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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : C07K 14/475, 14/50, A61K 38/18	A1	(11) International Publication Number: WO 99/41282 (43) International Publication Date: 19 August 1999 (19.08.99)
(21) International Application Number: PCT/US99/03018 (22) International Filing Date: 12 February 1999 (12.02.99) (30) Priority Data: 60/074,585 13 February 1998 (13.02.98) US 60/114,387 30 December 1998 (30.12.98) US (71) Applicant (for all designated States except US): HUMAN GENOME SCIENCES, INC. [US/US]; 9410 Key West Avenue, Rockville, MD 20850 (US). (72) Inventors; and (75) Inventors/Applicants (for US only): JIMENEZ, Pablo [US/US]; 3843 College Avenue, Ellicott City, MD 21043 (US). RAMPY, Mark, A. [US/US]; 10224 Wild Apple Circle, Montgomery Village, MD 20886 (US). MENDRICK, Donna [US/US]; 29112 Ridge Road, Mt. Airy, MD 21771 (US). RUSSELL, Deborah [US/US]; 21104 Golf Estates Drive, Laytonville, MD 20882 (US). LOUIE, Arthur [US/US]; 10817 Maple Crest Lane, Potomac, MD 20854 (US). (74) Agents: STEFFE, Eric, K.; Sterne, Kessler, Goldstein & Fox P.L.L.C., Suite 600, 1100 New York Avenue, N.W., Washington, DC 20005-3934 (US) et al.		(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i> <i>With an indication in relation to deposited biological material furnished under Rule 13bis separately from the description.</i>
(54) Title: THERAPEUTIC USES OF KERATINOCYTE GROWTH FACTOR-2 (57) Abstract The present invention relates to the administration of Keratinocyte Growth Factor-2 (KGF-2) to stimulate proliferation of platelets and to increase levels of fibrinogen, albumin, globulin and total serum protein. Further, the present invention relates to administering KGF-2 to protect or treat the bladder and prostate. Moreover, the present invention relates to administering KGF-2 to stimulate growth of nasal, oral, and esophageal mucosa, lacrimal glands, salivary glands and Goblet cells.		

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Therapeutic Uses of Keratinocyte Growth Factor-2

Field of the Invention

5 The present invention relates to the administration of Keratinocyte Growth Factor-2 (KGF-2) to increase levels of platelets, fibrinogen, albumin, globulin and total serum protein. Further, the present invention relates to administering KGF-2 to protect or treat the bladder and prostate. Moreover, the present invention relates to administering KGF-2 to stimulate growth of nasal, oral, and esophageal mucosa, lacrimal glands, salivary glands and Goblet cells.

Background of the Invention

10 Thrombocytopenia is a condition in which there is an abnormally small number of platelets in the circulating blood (Stedman's Medical Dictionary, 26th edition, Marjory Spraycar, Editor (1995). Thrombocytopenia results from various causes, but ultimately occurs when platelets are destroyed, sequestered in the body, or not produced. The differential diagnosis of thrombocytopenia is
15 extensive and complex, and there is a significant overlap among disorders (Doyle B, and Porter D.L. A.A.C.N. Clin. Issues 8: 469-480 (1997).

 Thrombocytopenia may be caused by a variety of mechanisms including, but not limited to, drug induced hypersensitivity, idiopathic thrombocytopenia purpura (ITP), posttransfusion purpura, neonatal thrombocytopenia, bone marrow
20 deficiencies identified with metastatic tumors to the bone, aplastic anemia, myelofibrosis, acute and monocytic leukemia, microangiopathic hemolytic anemia which includes disseminated intravascular coagulation (DIC), thrombotic thrombocytopenic purpura (TTP), hemolytic-uremic syndrome, prosthetic valve hemolytic syndrome, cancer chemotherapy, Zieve's syndrome, sepsis, HELLP
25 preclamptic syndrome, megaloblastic anemia due to B12 and folic acid deficiency, infections such as peritonitis (without septicemia), congenital rubella syndrome, HIV-1 virus infections, Epstein-Barr infectious mononucleosis, rheumatoid-collagen diseases such as systemic lupus, hypertension of pregnancy

associated with preclampsias, thyrotoxicosis and uremia (*Clinical guide to laboratory tests*. (3rd ed). Philadelphia, W.B. Saunders Company, 1995; *Clinical Laboratory Medicine. Clinical application of laboratory data*. (6th ed.) St. Louis, Mosby, 1995).

5 Fibrinogen is an abundant plasma glycoprotein that is synthesized in the liver. Thrombin sequentially cleaves fibrinopeptides A and B from the α and β chains of fibrinogen to produce fibrin monomer, which then polymerizes to form a fibrin clot which is the final major step in the coagulation process. Mutations have been identified which alter the release of fibrinopeptides from the α and β chains of fibrinogen, the rate of polymerization of fibrin monomers, and the sites for fibrin cross-linking. This mutations lead to dysfibrinogenemias which are almost always inherited as autosomal dominant traits. Patients with afibrinogenemia, who have no detectable fibrinogen in plasma or platelets, may have infrequent, mild spontaneous bleeding episodes. (Harrison's Principles of Internal Medicine 11th edition Eugene Braunwald et. al., Editors (1987)).

15 Hypofibrinogenemia refers to a condition in which there is an abnormally low concentration of fibrinogen in the circulating blood plasma (Stedman's Medical Dictionary, 26th edition, Marjory Spraycar, Editor (1995)). Hypofibrinogenemia may be caused by a variety of conditions or afflictions including, but not limited to, abnormal hepatic synthesis such as that associated with acute hepatitis or cirrhosis, and disseminated intravascular coagulation (DIC).

20 Albumin, the major serum protein, is considered to be responsible for maintenance of normal serum colloid osmotic pressure, transport of certain hormones and maintaining an endogenous source of amino acids (Buehler, B.A. Ann. Clin. Lab. Sci. 8: 283-286 (1978)). Hypoalbuminemia is a condition in which there is an abnormally low concentration of albumin in the circulating blood. The serum albumin level is one of several clinical parameters of the status of general health. There is a marked correlation between low albumin levels and the incidence of morbidity and mortality in hospitalized patients. Therefore, it is

not surprising to find that hypoalbuminemia is a common finding among hospitalized patients. Hypoalbuminemia is known to be associated with delayed wound healing. The hypoalbuminemic state interferes with the normal functioning of the gastrointestinal tract. Qualitative changes in the albumin molecule which occur in renal disease may damage the nephron. Low serum albumin levels may adversely affect the coagulation system (Doweiko, J.P., and Nompleggi, D.J. J.P.E.N. J. Parenter. Enteral. Nutr. 15: 476-483 (1991)).

Hypoalbuminemia can be caused by a variety of afflictions or conditions including, but not limited to, hemorrhages, burns, exudates, rheumatic diseases, granulomatous processes, most bacterial infections, viral infections accompanied by tissue destruction, tissue necrosis, vasculitis, ulcerative bowel disease, serositis, subacute bacterial endocarditis, parasitic infestations, acute and chronic liver disease, amyloidosis, malnutrition, malignancy, congestive heart failure, constrictive pericarditis, cardiac valvular disease, nephrotic syndrome, trauma and crush injuries, gastrointestinal and lymphatic fistulae, and protein-losing gastroenteropathies (*Clinical guide to laboratory tests*. (3rd ed). Philadelphia, W.B. Saunders Company, 1995; *Clinical Laboratory Medicine. Clinical application of laboratory data*. (6th ed.) St. Louis, Mosby, 1995).

Globulin is the name for a family of proteins precipitated from plasma or serum by half-saturation with ammonium sulphate. Globulins may be fractionated by solubility, electrophoresis, ultracentrifugation, and other separation methods into many subgroups, the main subgroups being α -, β -, and γ -globulins. These differ with respect to associated lipids or carbohydrates and in their content of many physiologically important factors. Globulins include immunoglobulins in the β , and γ fractions, lipoproteins in the α and β fractions, gluco- or mucoproteins (orosomucoid, haptoglobulin), and metal binding and metal transporting proteins (such as transferrin, siderophilin, ceruloplasmin). Other substances found in globulin fractions are: macroglobulin, plasminogen, prothrombin, euglobulin, antihemophilic globulin, fibrinogen, and cryoglobulin (Stedman's Medical Dictionary, 26th edition, Marjory Spraycar, Editor (1995)).

Certain reasonably predictable changes take place in plasma protein levels in response to acute illness. Hypoglobulinemia refers to an abnormally low concentration of globulin in the circulating plasma. Hypoglobulinemia may result from a variety of conditions or afflictions including, but not limited to, alpha-1 antityrpsin deficiencies, severe liver disease, estrogen therapy, megaloblastic anemia, hypogammaglobulinemia and agammaglobulinemia (*Clinical guide to laboratory tests*. (3rd ed). Philadelphia, W.B. Saunders Company, 1995; *Clinical Laboratory Medicine. Clinical application of laboratory data*. (6th ed.) St. Louis, Mosby, 1995).

A decrease in total serum protein is associated with protein loss (protein-losing gastroenteropathies, acute burns, nephrotic syndrome) and decreased synthesis of protein (chronic liver disease, malabsorption syndrome, malnutrition, and agammaglobulinemia).

Hemorrhagic cystitis is a syndrome associated with certain disease states as well as exposure to drugs, viruses, and toxins. It manifests as diffuse bleeding of the endothelial lining of the bladder. Treatment includes intravesical, systemic, and nonpharmacologic therapies (West, N.J. *Pharmacotherapy* 17: 696-706 (1997)).

Loss of the ability to produce adequate amounts of saliva and tears is a major clinical problem affecting millions of people and there are few therapeutic options for these sufferers. Patients with xerostomia, or dry mouth, have difficulty swallowing, have painful cracks in their mouths, and experience a decrease in their ability to taste. This condition may be caused by Sjogren's syndrome, as a secondary event to radiation used with patients with head and neck tumors, and to drugs. Patients with Sjogren's syndrome sometimes have keratoconjunctivitis sicca or dry eye. This condition may be caused by damage to the lacrimal gland due to Sjogren's syndrome, sarcoidosis, aging, HIV infection, burns, etc. Patients experience irritation, blurring of vision, burning, pain, and increased risk of infections. Millions of patients suffer with Sjogren's syndrome and therapy is sub-optimal.

As is the case with xerostomia, patients with keratoconjunctivitis sicca have few therapeutic options. At this time there are approximately 10 million patients in the US which require artificial tear preparations (Lemp, M.A, *Adv. Exp. Med. Biol.* 438:791-803 (1998)). There are no treatments available at this time to stimulate replacement of the cells in the salivary and lacrimal gland cells.

Sinus infections usually occur in the setting of upper respiratory tract infections, allergies, or anatomic defects (within the sinuses or nasal septum) and may lead to symptoms of headache, facial pain, fever, and purulent rhinorrhea. (Evans KL. *Drugs* 56(1): 59-71 (1998)). The symptoms of nasal allergy and chronic ethmoid sinusitis overlap and treatment failure in allergic patients may suggest possible chronic sinusitis. Chronic ethmoidal sinusitis may be the leading cause of rhinorrhea and nasal obstruction in patients with perennial allergies. (Bertrand *et al.*, *Acta Otorhinolaryngol Belg* 51(4):227-237 (1997)). Acute sinusitis tends to occur in patients with a history of rhinitis, which may be allergic or non-allergic in origin. Patients with anatomic variants (Evans KL. *Drugs* 56(1): 59-71 (1998)) and cystic fibrosis (Brihaye *et al.*, *Acta Otorhinolaryngol Belg* 51(4):323-337 (1997); Ramsey *et al.*, *J. Allergy Clin. Immunol.* 90(3Pt2):547-552 (1992); Davidson *et al.*, *Laryngoscope* 105(4Pt1):354-358 (1995); Jones *et al.*, *Int. J. Pediatr. Otorhinolaryngol.* 28(1):25-32 (1993)) are also at high risk for developing sinusitis. In particular, it is known that occlusion of the sinus ostia starts the cycle of events, which lead to and sustain sinusitis. (Reilly J.S. *Otolaryngology Head and Neck Surgery* 103(5):856-862(1990)). The goals of treatment for both acute and chronic sinusitis are to control the rhinitis, improve ventilation to the sinuses, and to improve the function of the sinuses for clearance of secretions. (Evans KL. *Drugs* 56(1): 59-71 (1998)).

Surgical treatment of the nasal sinuses is only considered when medical measures fail to control the sinusitis. The goals of treatment are identical: to improve ventilation and to facilitate or restore sinus drainage. An additional goal is that surgical treatment may sometimes improve the penetration of topical drugs into the sinus. Up to 250,000 procedures are performed each year in the United

States. However, in the course of performing sinus surgery, the mucosal surface is stripped away or damaged. In cases where the surgery has been extensive, the underlying bone within the sinus may be exposed for periods of up to 6 months before the mucosa is fully reconstituted and recovery of ciliary density may require up to 2 years to achieve. Delayed re-epithelialization of the nasal sinuses following surgery is believed to be associated with increased risk of infection, scarring (subepithelial fibrosis) leading to recurrent disease, and cyst formation. After 2 years of follow up approximately 2-5% of patients will have recurrent disease and up to 15% may require surgical revision. (Evans KL. *Drugs* 56(1): 59-71 (1998)).

Thus, there is clearly a need in the art for therapeutic proteins capable of increasing levels of platelets, fibrinogen, albumin, globulin and total serum protein. Further, there is a need for therapies capable of treating or protecting against damage caused by cystitis. Moreover, there is a need for stimulating the proliferation of cells in the salivary and lacrimal glands; and stimulating re-epithelialization of the sinuses and the growth of nasal mucosa in the nasal sinuses after surgery.

Summary of the Invention

The present invention provides isolated nucleic acid molecules comprising a polynucleotide encoding the keratinocyte growth factor (KGF-2) having the amino acid sequence is shown in Figure 1 [SEQ ID NO:2] or the amino acid sequence encoded by the cDNA clone deposited as ATCC Deposit Number 75977 on December 16, 1994. The nucleotide sequence determined by sequencing the deposited KGF-2 clone, which is shown in Figure 1 [SEQ ID NO:1], contains an open reading frame encoding a polypeptide of 208 amino acid residues, including an initiation codon at positions 1-3, with a predicted leader sequence of about 35 or 36 amino acid residues, and a deduced molecular weight

of about 23.4 kDa. The amino acid sequence of the mature KGF-2 is shown in Figure 1, amino acid residues about 36 or 37 to 208 [SEQ ID NO:2].

The polypeptide of the present invention has been identified as a member of the FGF family, more particularly the polypeptide has been identified as KGF-2 as a result of amino acid sequence homology with other members of the FGF family.

In accordance with one aspect of the present invention, there are provided novel mature polypeptides which are KGF-2 as well as biologically active and diagnostically or therapeutically useful fragments, analogs and derivatives thereof. The polypeptides of the present invention are of human origin.

In accordance with another aspect of the present invention, there are provided isolated nucleic acid molecules encoding human KGF-2, including mRNAs, DNAs, cDNAs, genomic DNA, as well as antisense analogs thereof, and biologically active and diagnostically or therapeutically useful fragments thereof.

In accordance with another aspect of the present invention, there is provided a process for producing such polypeptides by recombinant techniques through the use of recombinant vectors, such as cloning and expression plasmids useful as reagents in the recombinant production of KGF-2 proteins, as well as recombinant prokaryotic and/or eukaryotic host cells comprising a human KGF-2 nucleic acid sequence.

In accordance with yet a further aspect of the present invention, there is provided therapeutic methods such as increasing platelet levels by administering KGF-2 for the purpose of alleviating thrombocytopenia. KGF-2 can also be used to increase the levels of plasma fibrinogen which may be found in conditions of abnormal hepatic synthesis (such as that associated with acute hepatitis or cirrhosis) and disseminated intravascular coagulation. KGF-2 can further be used to increase levels of serum albumin in patients with hypoalbuminemia. KGF-2 can also be used to increase the levels of serum globulin found in patients with hypoglobulinemia. KGF-2 can also be used to increase the levels of total serum protein in patients with protein loss and decreased protein synthesis.

KGF-2 can further be used to inhibit toxic effects on the prostate and bladder and to reduce the extent of ulceration caused by cystitis.

KGF-2 can also be used to stimulate the growth of sinus epithelia, nasal mucosa, lacrimal glands and salivary glands.

5

Brief Description of the Figures

Figures 1A-1C illustrate the cDNA and corresponding deduced amino acid sequence of the polypeptide of the present invention. The initial 35 or 36 amino acid residues represent the putative leader sequence (underlined). The standard one letter abbreviations for amino acids are used. Sequencing inaccuracies are a common problem when attempting to determine polynucleotide sequences. Sequencing was performed using a 373 Automated DNA sequencer (Applied Biosystems, Inc.). Sequencing accuracy is predicted to be greater than 97% accurate. [SEQ ID NO:1]

Figures 2A-2D are an illustration of a comparison of the amino acid sequence of the polypeptide of the present invention and other fibroblast growth factors. [SEQ ID NOS:13-22]

Figures 3A-3D show the full length mRNA and amino acid sequence for the KGF-2 gene. [SEQ ID NOS:23 and 24]

Figures 4A-4E show an analysis of the KGF-2 amino acid sequence. Alpha, beta, turn and coil regions; hydrophilicity and hydrophobicity; amphipathic regions; flexible regions; antigenic index and surface probability are shown. In the "Antigenic Index - Jameson-Wolf" graph, amino acid residues 41--109 in Figure 1 [SEQ ID NO:2] correspond to the shown highly antigenic regions of the KGF-2 protein. Hydrophobic regions (Hopp-Woods Plot) fall below the median line (negative values) while hydrophilic regions (Kyte-Doolittle Plot) are found above the median line (positive values, e.g. amino acid residues 41--109). The plot is over the entire 208 amino acid ORF.

Figure 5 shows the DNA sequence and the protein expressed from the pQE60-Cys37 construct [SEQ ID NOS:29 and 30]. The expressed KGF-2 protein contains the sequence from Cysteine at position 37 to Serine at position 208 with a 6X(His) tag attached to the N-terminus of the protein.

5 Figure 6 (A) shows the stimulation of normal primary epidermal keratinocyte proliferation by KGF-2. (B) shows the stimulation of normal primary epidermal keratinocyte proliferation by KGF-2 Δ 33. (C) shows the stimulation of normal primary epidermal keratinocyte proliferation by KGF-2 Δ 28. Human normal primary epidermal keratinocytes were incubated with
10 various concentrations of KGF-2, KGF-2 Δ 33 or KGF-2 Δ 28 for three days. For all three experiments alamarBlue was then added for 16 hr and the intensity of the red color converted from alamarBlue by the cells was measured by the difference between O.D. 570 nm and O.D. 600 nm. For each of the KGF-2 proteins a positive control with complete keratinocyte growth media (KGM), and a
15 negative control with keratinocyte basal media (KBM) were included in the same assay plate.

Figure 7 (A) shows the stimulation of thymidine incorporation by KGF-2 and FGF7 in Baf3 cells transfected with FGFR1b and FGFR2. The effects of KGF-2 (right panel) and FGF7 (left panel) on the proliferation of Baf3 cells
20 transfected with FGFR1iib (open circle) or FGFR2iib/KGFR (solid Circle) were examined. Y-axis represents the amount of [3 H]thymidine incorporation (cpm) into DNA of Baf3 cells. X-axis represents the final concentration of KGF-2 or FGF7 added to the tissue culture media. (B) shows the stimulation of thymidine incorporation by KGF-2 Δ 33 in Baf3 cells transfected with FGFR2iib
25 (C) shows the stimulation of thymidine incorporation by KGF-2 (white bar), KGF-2 Δ 33 (black bar) and KGF-2 Δ 28 (grey bar) in Baf3 cells transfected with FGFR2iib.

Figure 8 shows a schematic representation of the pHE4-5 expression vector (SEQ ID NO:147) and the subcloned KGF-2 cDNA coding sequence. The

locations of the kanamycin resistance marker gene, the KGF-2 coding sequence, the oriC sequence, and the *lacIq* coding sequence are indicated.

Figure 9 shows the nucleotide sequence of the regulatory elements of the pHE promoter (SEQ ID NO:148). The two *lac* operator sequences, the Shine-Delgarno sequence (S/D), and the terminal *Hind*III and *Nde*I restriction sites (italicized) are indicated.

Figure 10 shows the DNA and protein sequence [SEQ ID NOS:38 and 39] for the E.coli optimized full length KGF-2.

Figures 11A and B show the DNA and protein sequences [SEQ ID NOS:42, 43, 54, and 55] for the E.coli optimized mature KGF-2.

Figure 12 shows the DNA and the encoded protein sequence [SEQ ID NOS:65 and 66] for the KGF-2 deletion construct comprising amino acids 36 to 208 of KGF-2.

Figure 13 shows the DNA and the encoded protein sequence [SEQ ID NOS:67 and 68] for the KGF-2 deletion construct comprising amino acids 63 to 208 of KGF-2.

Figure 14 shows the DNA and the encoded protein sequence [SEQ ID NOS:69 and 70] for the KGF-2 deletion construct comprising amino acids 77 to 208 of KGF-2.

Figure 15 shows the DNA and the encoded protein sequence [SEQ ID NOS:71 and 72] for the KGF-2 deletion construct comprising amino acids 93 to 208 of KGF-2.

Figure 16 shows the DNA and the encoded protein sequence [SEQ ID NOS:73 and 74] for the KGF-2 deletion construct comprising amino acids 104 to 208 of KGF-2.

Figure 17 shows the DNA and the encoded protein sequence [SEQ ID NOS:75 and 76] for the KGF-2 deletion construct comprising amino acids 123 to 208 of KGF-2.

Figure 18 shows the DNA and the encoded protein sequence [SEQ ID NOS:77 and 78] for the KGF-2 deletion construct comprising amino acids 138 to 208 of KGF-2.

5 Figure 19 shows the DNA and the encoded protein sequence [SEQ ID NOS:79 and 80] for the KGF-2 deletion construct comprising amino acids 36 to 153 of KGF-2.

Figure 20 shows the DNA and the encoded protein sequence [SEQ ID NOS:81 and 82] for the KGF-2 deletion construct comprising amino acids 63 to 153 of KGF-2.

10 Figure 21 shows the DNA sequence for the KGF-2 Cysteine-37 to Serine mutant construct [SEQ ID NO:83].

Figure 22 shows the DNA sequence for the KGF-2 Cysteine-37/Cysteine-106 to Serine mutant construct [SEQ ID NO:84].

15 Figure 23 shows the proliferation of bladder epithelium following ip or sc administration of KGF-2 Δ 33.

Figure 24 shows the proliferation of prostatic epithelial cells after systemic administration of KGF-2 Δ 33.

Figure 25 shows the effect of KGF-2 Δ 33 on bladder wall ulceration in a cyclophosphamide-induced hemorrhagic cystitis model in the rat.

20 Figure 26 shows the effect of KGF-2 Δ 33 on bladder wall thickness in a cyclophosphamide-induced cystitis rat model.

Figure 27 provides an overview of the study design to determine whether KGF-2 Δ 33 induces proliferation of normal epithelia in rats when administered systemically using SC and IP routes.

25 Figure 28. Normal Sprague Dawley rats were injected daily with KGF-2 Δ 33 (5 mg/kg; HG03411-E2) or buffer and sacrificed one day after the final injection. A blinded observer counted the proliferating cells in ten randomly chosen fields per animals at a 10 x magnification. SC administration of KGF-2 Δ 33 elicited a significant proliferation after one day which then returned to

normal by 2 days. KGF-2 Δ 33 given ip stimulated proliferation from 1-3 days but only the results from days 1 and 3 were statistically significant.

Figure 29. Normal Sprague Dawley rats were injected daily with KGF-2 Δ 33 (5 mg/kg; HG03411-E2) or buffer and sacrificed one day after the final injection. A blinded observer counted the proliferating cells in ten randomly chosen fields per animal at a 10 x magnification. KGF-2 Δ 33 given ip stimulated proliferation over the entire study period while sc administration of KGF-2 Δ 33 did not increase the proliferation at any time point.

Figure 30. Normal Sprague Dawley rats were injected daily with KGF-2 Δ 33 (5 mg/kg; HG03411-E2) or buffer and sacrificed one day after the final injection. A blinded observer counted the proliferating cells in one cross-section per animal at a 10 x magnification. KGF-2 Δ 33 given sc elicited a significant increase in proliferation after 1, 2, and 3 days of daily administration. When KGF-2 Δ 33 was given ip, proliferation was seen after 2 and 3 days only.

Figure 31 demonstrates KGF-2 Δ 33 induced proliferation in normal rat lung.

Figure 32 shows a morphometric assessment of the number of BrdU positive cells in the parotid gland revealed dramatic proliferation over the seven day study period. Note that BrdU incorporation returned to normal after a seven day rest period. Measurements were performed in a blinded manner.

Figure 33 shows the weight of the parotid glands from animals treated daily with KGF-2 or buffer are expressed as mg per g of body weight. Only after seven daily intravenous injections of KGF-2 did the organ weight significantly increase and this normalized after a seven day rest period.

Figure 34 shows the proliferative effect of KGF-2 on the submandibular gland was apparent after one injection (day 1). It remained active over three doses but after seven daily injections was no longer inducing a significant increase in proliferation. All measurements were performed in a blinded manner.

Figure 35 shows the weight of the submandibular glands obtained from rats treated daily with KGF-2 showed a significant increase in size after two

injections. This enlargement peaked after seven daily injections. After one week of recovery the weight of the submandibular gland from rats treated with KGF-2 had begun to normalize but was still significant larger than tissue taken from buffer treated control rats.

5 Figure 36 shows the proliferation of the lacrimal gland after 1, 2 and 3 daily i.v. injections of KGF-2Δ33. Animals were used in groups of 6, and the proliferation of the tissue was assessed by a blinded observer using a computerized morphometry unit. The proliferation results are expressed as the percentage of a region of interest that has proliferating cells (% ROI). The error
10 bars reflect the SEM. Statistical analysis was performed using StatView. A factorial ANOVA was performed followed by a Scheffé post-hoc test and statistical significant was defined as $p < 0.05$.

 Figure 37 shows the effect of KGF-2 intravenous injection at days 1, 2, 3 and 7 on the cornea. The results express the replicating epithelia as number of
15 cells per mm of tissue. An increase in the number of proliferating cells following KGF-2 treatment on days 1 and 2 was observed. However, only the results from day 2 attained statistical significance.

 Figure 38 shows the results of KGF-2 intravenous injection at days 1, 2, 3 and 7 on the conjunctiva. The results express the replicating epithelia as
20 number of cells per mm of tissue. An increase in the number of proliferating cells following KGF-2 treatment on days 1, 2 and 3 was observed. These results were statistically significant.

 Figures 39 (A) and (B) show the results of KGF-2Δ33 daily intravenous injections on pilocarpine-induced salivation. Figure 39(A) shows KGF-2Δ33
25 treatment induces a large increase in saliva production in the treated animals. Figure 39(B) shows that the concentration of amylase in saliva is decreased following the daily KGF-2Δ33 injections.

 Figure 40 shows the results of KGF-2 intravenous injection at days 1, 2, 3, 7 and 14 on the maxillary sinus in normal rats. There was an increase in the
30 total number of proliferating cells following KGF-2 treatment on Days 1, 2, 3

and 7. All days, except Day 14, attained statistical significance. By day 14, the number of proliferating cells returned to normal.

Figure 41 shows the results of KGF-2Δ33 intravenous injection at days 1, 2, 3, 7 and 14 on the nasal septum in normal rats. There was an increase in the total number of proliferating cells following KGF-2 treatment on Days 1, 2, 3 and 7. All days, except Day 14, attained statistical significance. By day 14, the number of proliferating cells returned to normal.

Figure 42 shows the effect of KGF-2Δ33 on the number of goblet cells in the conjunctiva in male rats intravenously injected with either KGF-2Δ33 or buffer at days 1, 2, 3, and 7.

Figure 43 shows the effect of intravenous KGF-2 on lung proliferation. Male SD rats received buffer or KGF-2Δ33 i.v. (1 or 5 mg/kg) on day 1. Animals were injected with BrdU (100 mg/kg, i.p.) 2 hours prior to euthanasia. Animals were sacrificed at 6, 24, or 48 hour time points. The average number of BrdU positive cells per field was counted in 5 random fields at 20X. Statistical significance is achieved using the unpaired t-test where $p < 0.05$ when compared to the buffer control.

Figure 44 shows the effect of nebulized KGF-2 on proliferation in normal rat lungs. Male Lewis rats inhaled nebulized buffer or KGF-2Δ33 (56 or 12 mg/rat). Twenty four hours post-nebulization, animals received BrdU (100mg/kg, i.p.) 2 hours prior to euthanasia. The average number of positively stained cells in 5 random microscopic fields (20X) per lobe was the BrdU cell count.

Figure 45 shows the effect of prophylactic KGF-2Δ33 on body weights in a bleomycin-induced lung injury rat model. Male rats were given intratracheal doses of KGF-2Δ33 (0.5, 1 and 5 mg/kg) or buffer. Treatments were given on day 0 and day 1. Bleomycin was given on day 3. Animals were weighed on alternate days until the 14th day. Statistical analysis was done using an unpaired t-test. *compared with the no treatment group; **compared to the KGF-2 buffer group.

Figure 46 shows the effect of prophylactic KGF-2Δ33 on fibrosis score in bleomycin-induced lung injury rat model. Male Lewis rats (n=5) were

given intratracheal doses of KGF-2 Δ 33 0.5 mg/ml, 1 mg/ml, 5 mg/ml or buffer while under anesthesia. Treatments were given on day 0 and day 1. Bleomycin was administered on day 3. On the final day of the experiment (day 14), animals were injected with BrdU (100 mg/kg, i.p.) 2 hours prior to euthanasia. The scoring was graded 0 = normal, 1-3 = mild, 4-6 = moderate, and 7-9 = severe at 10X. Statistical analysis was performed with a student's paired t-test. *compared to buffer treatment group, ** compared to no treatment group.

Figure 47 shows the effect of prophylactic KGF-2 Δ 33 on bleomycin-induced lung injury rat model. Male Lewis rats (n=5) were given intratracheal doses of KGF-2 0.5 mg/ml, 1 mg/ml, 5 mg/ml or buffer while under anesthesia. Treatments were given on day 0 and day 1. Bleomycin was administered on day 3. On the final day of the experiment (day 14), animals were injected with BrdU (100 mg/kg, i.p.) 2 hours prior to euthanasia. The number of BrdU positive cells per field was counted in 10 random fields at 20X. Statistical analysis was performed with a student's paired t-test. *compared to Buffer treatment group **compared to no treatment group.

Figure 48 shows the effect of KGF-2 Δ 33 on bladder capacity in cyclophosphamide-induced cystitis rat model. Male SD rats (200g) received KGF-2 Δ 33 in doses of 0.1 mg/kg, 0.3 mg/kg, 1.0 mg/kg or 3.0 mg/kg intravenously. On day 1, 200 mg/kg of cyclophosphamide (CP) was administered i.p. Animals were sacrificed on day 4. After urine was removed from the bladder, it was filled with formalin until it leaked out of the urethra. The volume of formalin injected into the bladders was recorded as the bladder capacity. (* compared to CP only control; † compared to buffer control).

Figure 49 shows the effect of KGF-2 Δ 33 on bladder wet weight in cyclophosphamide-induced cystitis rat model. Male SD rats (200g) received KGF-2 Δ 33 in doses of 0.1 mg/kg, 0.3 mg/kg, 1.0 mg/kg or 3.0 mg/kg intravenously. On day 1, 200 mg/kg of cyclophosphamide (CP) was administered i.p. Animals were sacrificed on day 4. Bladders were fixed in

formalin, harvested, weighed and then placed in tissue cassettes for histological analysis. (* compared to CP only control; † compared to buffer control).

Figure 50 shows the effect of KGF-2Δ33 and mesna on bladder ulceration of cyclophosphamide-induced cystitis. Male S.D. rats (200g) received either buffer or 5.0 mg/kg KGF-2Δ33 intravenously on day 0. On day 1, 200 mg/kg of cyclophosphamide (CP) i.p and Mesna (20 μg/g or 40 μg/g, i.v.). Animals were sacrificed on day 3 and bladders were fixed internally with formalin before tissue harvest. Saline was used as a normal control. Statistical analysis was performed using the unpaired t-test where significance is found if $p \leq 0.05$. *Compared to CP only; **compared to buffer.

Figure 51 shows the effect of KGF-2Δ33 and mesna on percent normal urothelium of cyclophosphamide-induced cystitis. Male S.D. rats (200g) received either buffer or 5.0 mg/kg KGF-2Δ33 intravenously on day 0. On day 1, 200 mg/kg of cyclophosphamide (CP) i.p and Mesna (20 μg/g or 40 μg/g, i.v.). Animals were sacrificed on day 3 and bladders were fixed internally with formalin before tissue harvest. Saline was used as a normal control. Statistical analysis was performed using the unpaired t-test where significance is found if $p \leq 0.05$. *Compared to CP only; **compared to buffer.

Figure 52 shows the effect of KGF-2Δ33 and mesna on bladder wall thickness of cyclophosphamide-induced cystitis. Male S.D. rats (200g) received either buffer or 5.0 mg/kg KGF-2Δ33 intravenously on day 0. On day 1, 200 mg/kg of cyclophosphamide (CP) i.p and Mesna (20 μg/g or 40 μg/g, i.v.). Animals were sacrificed on day 3 and bladders were fixed internally with formalin before tissue harvest. Saline was used as a normal control. Statistical analysis was performed using the unpaired t-test where significance is found if $p \leq 0.05$. *Compared to CP only; **compared to buffer.

Figure 53 shows the synergistic effect of KGF-2Δ33 and mesna on bladder capacity of cyclophosphamide-induced cystitis. Male SD rats (350-400 g) (n=7) received, on day 0, either buffer or 5.0 mg/kg KGF-2Δ33 intravenously and on day 1, Mesna (40 μg/g, i.v.) or both treatments on the respective

administration days. Cyclophosphamide (300 mg/kg, i.p.) was administered on day 1 to all treatment groups with the exception of the saline control. One group was added as a CP control with no treatment. On day 3, animals received BrdU (100mg/kg, i.p.) 2 hours prior to euthanasia. After urine was removed from the bladder, it was filled with formalin until it leaked out of the urethra. The volume of formalin injected into the bladder was recorded as the bladder capacity.

*Compared to CP only control; † compared to buffer control.

Figure 54 shows the synergistic effect of KGF-2Δ33 and mesna on bladder wet weight of cyclophosphamide-induced cystitis. Male SD rats (350-400 g) (n=7) received, on day 0, either buffer or 5.0 mg/kg KGF-2Δ33 intravenously and on day 1, Mesna (40 μg/g, i.v.) or both treatments on the respective administration days. Cyclophosphamide (300 mg/kg, i.p.) was administered on day 1 to all treatment groups with the exception of the saline control. One group was added as a CP control with no treatment. On day 3, animals received BrdU (100mg/kg, i.p.) 2 hours prior to euthanasia. Bladders were fixed with 10% neutral-buffered formalin, weighed and placed in tissue cassettes for histological analysis. *Compared to CP only control; † compared to buffer control.

Detailed Description

In accordance with an aspect of the present invention, there is provided an isolated nucleic acid (polynucleotide) which encodes for the polypeptide having the deduced amino acid sequence of Figure 1 (SEQ ID NO:2) or for the polypeptide encoded by the cDNA of the clone deposited as ATCC Deposit No. 75977 on December 16, 1994 at the American Type Culture Collection, Patent Depository, 10801 University Blvd, Manassas, VA 20110-2209.

Nucleic Acid Molecules

Unless otherwise indicated, all nucleotide sequences determined by sequencing a DNA molecule herein were determined using an automated DNA sequencer (such as the Model 373 from Applied Biosystems, Inc.), and all amino acid sequences of polypeptides encoded by DNA molecules determined herein were predicted by translation of a DNA sequence determined as above. Therefore, as is known in the art for any DNA sequence determined by this automated approach, any nucleotide sequence determined herein may contain some errors. Nucleotide sequences determined by automation are typically at least about 90% identical, more typically at least about 95% to at least about 99.9% identical to the actual nucleotide sequence of the sequenced DNA molecule. The actual sequence can be more precisely determined by other approaches including manual DNA sequencing methods well known in the art. As is also known in the art, a single insertion or deletion in a determined nucleotide sequence compared to the actual sequence will cause a frame shift in translation of the nucleotide sequence such that the predicted amino acid sequence encoded by a determined nucleotide sequence will be completely different from the amino acid sequence actually encoded by the sequenced DNA molecule, beginning at the point of such an insertion or deletion.

Unless otherwise indicated, each "nucleotide sequence" set forth herein is presented as a sequence of deoxyribonucleotides (abbreviated A, G, C and T). However, by "nucleotide sequence" of a nucleic acid molecule or polynucleotide is intended, for a DNA molecule or polynucleotide, a sequence of deoxyribonucleotides, and for an RNA molecule or polynucleotide, the corresponding sequence of ribonucleotides (A, G, C and U), where each thymidine deoxyribonucleotide (T) in the specified deoxyribonucleotide sequence is replaced by the ribonucleotide uridine (U). For instance, reference to an RNA molecule having the sequence of SEQ ID NO:1 set forth using deoxyribonucleotide abbreviations is intended to indicate an RNA molecule

having a sequence in which each deoxyribonucleotide A, G or C of SEQ ID NO:1 has been replaced by the corresponding ribonucleotide A, G or C, and each deoxyribonucleotide T has been replaced by a ribonucleotide U.

By "isolated" nucleic acid molecule(s) is intended a nucleic acid molecule, DNA or RNA, which has been removed from its native environment. For example, recombinant DNA molecules contained in a vector are considered isolated for the purposes of the present invention. Further examples of isolated DNA molecules include recombinant DNA molecules maintained in heterologous host cells or purified (partially or substantially) DNA molecules in solution. Isolated RNA molecules include *in vivo* or *in vitro* RNA transcripts of the DNA molecules of the present invention. Isolated nucleic acid molecules according to the present invention further include such molecules produced synthetically.

Isolated nucleic acid molecules of the present invention include DNA molecules comprising an open reading frame (ORF) with an initiation codon at positions 1-3 of the nucleotide sequence shown in Figure 1 (SEQ ID NO:1); DNA molecules comprising the coding sequence for the mature KGF-2 protein shown in Figure 1 (last 172 or 173 amino acids) (SEQ ID NO:2); and DNA molecules which comprise a sequence substantially different from those described above but which, due to the degeneracy of the genetic code, still encode the KGF-2 protein. Of course, the genetic code is well known in the art. Thus, it would be routine for one skilled in the art to generate the degenerate variants described above.

A polynucleotide encoding a polypeptide of the present invention may be obtained from a human prostate and fetal lung. A fragment of the cDNA encoding the polypeptide was initially isolated from a library derived from a human normal prostate. The open reading frame encoding the full length protein was subsequently isolated from a randomly primed human fetal lung cDNA library. It is structurally related to the FGF family. It contains an open reading frame encoding a protein of 208 amino acid residues of which approximately the first 35 or 36 amino acid residues are the putative leader sequence such that the mature protein comprises 173 or 172 amino acids. The protein exhibits the

highest degree of homology to human keratinocyte growth factor with 45% identity and 82% similarity over a 206 amino acid stretch. It is also important that sequences that are conserved through the FGF family are found to be conserved in the protein of the present invention.

5 In addition, results from nested PCR of KGF-2 cDNA from libraries showed that there were potential alternative spliced forms of KGF-2. Specifically, using primers flanking the N-terminus of the open reading frame of KGF-2, PCR products of 0.2 kb and 0.4 kb were obtained from various cDNA libraries. A 0.2 kb size was the expected product for KGF-2 while the 0.4 kb size
10 may result from an alternatively spliced form of KGF-2. The 0.4 kb product was observed in libraries from stomach cancer, adult testis, duodenum and pancreas.

The polynucleotide of the present invention may be in the form of RNA or in the form of DNA, which DNA includes cDNA, genomic DNA, and
15 synthetic DNA. The DNA may be doublestranded or single-stranded, and if single stranded may be the coding strand or non-coding (anti-sense) strand. The coding sequence which encodes the mature polypeptide may be identical to the coding sequence shown in Figure 1 (SEQ ID NO:1) or that of the deposited clone or may be a different coding sequence which coding sequence, as a result of the
20 redundancy or degeneracy of the genetic code, encodes the same mature polypeptide as the DNA of Figure 1 (SEQ ID NO:1) or the deposited cDNA.

The polynucleotide which encodes for the predicted mature polypeptide of Figure 1 (SEQ ID NO:2) or for the predicted mature polypeptide encoded by the deposited cDNA may include: only the coding sequence for the mature
25 polypeptide; the coding sequence for the mature polypeptide and additional coding sequence such as a leader or secretary sequence or a proprotein sequence; the coding sequence for the mature polypeptide (and optionally additional coding sequence) and non-coding sequence, such as intron or non-coding sequence 5' and/or 3' of the coding sequence for the predicted mature polypeptide. In

addition, a full length mRNA has been obtained which contains 5' and 3' untranslated regions of the gene (Figure 3 (SEQ ID NO:23)).

5 As one of ordinary skill would appreciate, due to the possibilities of sequencing errors discussed above, as well as the variability of cleavage sites for leaders in different known proteins, the actual KGF-2 polypeptide encoded by the deposited cDNA comprises about 208 amino acids, but may be anywhere in the range of 200-220 amino acids; and the actual leader sequence of this protein is about 35 or 36 amino acids, but may be anywhere in the range of about 30 to about 40 amino acids.

10 Thus, the term "polynucleotide encoding a polypeptide" encompasses a polynucleotide which includes only coding sequence for the polypeptide as well as a polynucleotide which includes additional coding and/or non-coding sequence.

15 The present invention further relates to variants of the hereinabove described polynucleotides which encode for fragments, analogs and derivatives of the polypeptide having the deduced amino acid sequence of Figure 1 (SEQ ID NO:2) or the polypeptide encoded by the cDNA of the deposited clone. The variant of the polynucleotide may be a naturally occurring allelic variant of the polynucleotide or a nonnaturally occurring variant of the polynucleotide.

20 Thus, the present invention includes polynucleotides encoding the same predicted mature polypeptide as shown in Figure 1 (SEQ ID NO:2) or the same predicted mature polypeptide encoded by the cDNA of the deposited clone as well as variants of such polynucleotides which variants encode for a fragment, derivative or analog of the polypeptide of Figure 1 (SEQ ID NO:2) or the polypeptide encoded by the cDNA of the deposited clone. Such nucleotide
25 variants include deletion variants, substitution variants and addition or insertion variants.

The present invention includes polynucleotides encoding mimetic peptides of KGF-2 which can be used as therapeutic peptides. Mimetic KGF-2 peptides
30 are short peptides which mimic the biological activity of the KGF-2 protein by

binding to and activating the cognate receptors of KGF-2. Mimetic KGF-2 peptides can also bind to and inhibit the cognate receptors of KGF-2. KGF-2 receptors include, but are not limited to, FGFR2iiiib and FGFR1iiiib. Such mimetic peptides are obtained from methods such as, but not limited to, phage display or combinatorial chemistry. For example the method disclosed by Wrighton et al. Science 273:458-463 (1996) to generate mimetic KGF-2 peptides.

As hereinabove indicated, the polynucleotide may have a coding sequence which is a naturally occurring allelic variant of the coding sequence shown in Figure 1 (SEQ ID NO:1) or of the coding sequence of the deposited clone. As known in the art, an allelic variant is an alternate form of a polynucleotide sequence which may have a substitution, deletion or addition of one or more nucleotides, which does not substantially alter the function of the encoded polypeptide.

The present invention also includes polynucleotides, wherein the coding sequence for the mature polypeptide may be fused in the same reading frame to a polynucleotide sequence which aids in expression and secretion of a polypeptide from a host cell, for example, a leader sequence which functions as a secretory sequence for controlling transport of a polypeptide from the cell. The polypeptide having a leader sequence is a preprotein and may have the leader sequence cleaved by the host cell to form the mature form of the polypeptide. The polynucleotides may also encode for proprotein which is the mature protein plus additional 5' amino acid residues. A mature protein having a prosequence is a proprotein and is an inactive form of the protein. Once the prosequence is cleaved an active mature protein remains.

Thus, for example, the polynucleotide of the present invention may encode for a mature protein, or for a protein having a prosequence or for a protein having both prosequence and a presequence (leader sequence).

The polynucleotides of the present invention may also have the coding sequence fused in frame to a marker sequence which allows for purification of the polypeptide of the present invention. The marker sequence may be a

hexahistidine tag supplied by a pQE-9 vector to provide for purification of the mature polypeptide fused to the marker in the case of a bacterial host, or, for example, the marker sequence may be a hemagglutinin (HA) tag when a mammalian host, e.g. COS-7 cells, is used. The HA tag corresponds to an epitope
5 derived from the influenza hemagglutinin protein (Wilson, I. *et al. Cell* 37:767 (1984)).

The term "gene" means the segment of DNA involved in producing a polypeptide chain; it includes regions preceding and following the coding region (leader and trailer) as well as intervening sequences (introns) between individual
10 coding segments (exons).

Fragments of the full length gene of the present invention may be used as a hybridization probe for a cDNA library to isolate the full length cDNA and to isolate other cDNAs which have a high sequence similarity to the gene or similar biological activity. Probes of this type preferably have at least 30 bases and may
15 contain, for example, 50 or more bases. The probe may also be used to identify a cDNA clone corresponding to a full length transcript and a genomic clone or clones that contain the complete gene including regulatory and promotor regions, exons, and introns. An example of a screen comprises isolating the coding region of the gene by using the known DNA sequence to synthesize an oligonucleotide
20 probe. Labeled oligonucleotides having a sequence complementary to that of the gene of the present invention are used to screen a library of human cDNA, genomic DNA or cDNA to determine which members of the library the probe hybridizes to.

Further embodiments of the invention include isolated nucleic acid
25 molecules comprising a polynucleotide having a nucleotide sequence at least 90% identical, and more preferably at least 95%, 96%, 97%, 98% or 99% identical to (a) a nucleotide sequence encoding the full-length KGF-2 polypeptide having the complete amino acid sequence in Figure 1 (SEQ ID NO:2), including the predicted leader sequence; (b) a nucleotide sequence encoding the mature KGF-2
30 polypeptide (full-length polypeptide with the leader removed) having the amino

acid sequence at positions about 36 or 37 to 208 in Figure 1 (SEQ ID NO:2); (c) a nucleotide sequence encoding the full-length KGF-2 polypeptide having the complete amino acid sequence including the leader encoded by the cDNA clone contained in ATCC Deposit No. 75977; (d) a nucleotide sequence encoding the mature KGF-2 polypeptide having the amino acid sequence encoded by the cDNA clone contained in ATCC Deposit No. 75977; (e) a nucleotide sequence encoding any of the KGF-2 analogs or deletion mutants described below; or (f) a nucleotide sequence complementary to any of the nucleotide sequences in (a), (b), (c), (d), or (e).

By a polynucleotide having a nucleotide sequence at least, for example, 95% "identical" to a reference nucleotide sequence of the present invention, it is intended that the nucleotide sequence of the polynucleotide is identical to the reference sequence except that the polynucleotide sequence may include up to five point mutations per each 100 nucleotides of the reference nucleotide sequence encoding the KGF-2 polypeptide. In other words, to obtain a polynucleotide having a nucleotide sequence at least 95% identical to a reference nucleotide sequence, up to 5% of the nucleotides in the reference sequence may be deleted or substituted with another nucleotide, or a number of nucleotides up to 5% of the total nucleotides in the reference sequence may be inserted into the reference sequence. The query sequence may be an entire sequence shown of SEQ ID NO:1, the ORF (open reading frame), or any fragment specified as described herein.

As a practical matter, whether any particular nucleic acid molecule or polypeptide is at least 90%, 95%, 96%, 97%, 98% or 99% identical to a nucleotide sequence of the present invention can be determined conventionally using known computer programs. A preferred method for determining the best overall match between a query sequence (a sequence of the present invention) and a subject sequence, also referred to as a global sequence alignment, can be determined using the FASTDB computer program based on the algorithm of Brutlag et al. (Comp. App. Biosci. (1990) 6:237-245.) In a sequence alignment

the query and subject sequences are both DNA sequences. An RNA sequence can be compared by converting U's to T's. The result of said global sequence alignment is in percent identity. Preferred parameters used in a FASTDB alignment of DNA sequences to calculate percent identify are: Matrix=Unitary, k-tuple=4, Mismatch Penalty=1, Joining Penalty=30, Randomization Group Length=0, Cutoff Score=1, Gap Penalty=5, Gap Size Penalty 0.05, Window Size=500 or the length of the subject nucleotide sequence, whichever is shorter. If the subject sequence is shorter than the query sequence because of 5' or 3' deletions, not because of internal deletions, a manual correction must be made to the results. This is because the FASTDB program does not account for 5' and 3' truncations of the subject sequence when calculating percent identity. For subject sequences truncated at the 5' or 3' ends, relative to the query sequence, the percent identity is corrected by calculating the number of bases of the query sequence that are 5' and 3' of the subject sequence, which are not matched/aligned, as a percent of the total bases of the query sequence. Whether a nucleotide is matched/aligned is determined by results of the FASTDB sequence alignment. This percentage is then subtracted from the percent identity, calculated by the above FASTDB program using the specified parameters, to arrive at a final percent identity score. This corrected score is what is used for the purposes of the present invention. Only bases outside the 5' and 3' bases of the subject sequence, as displayed by the FASTDB alignment, which are not matched/aligned with the query sequence, are calculated for the purposes of manually adjusting the percent identity score.

For example, a 90 base subject sequence is aligned to a 100 base query sequence to determine percent identity. The deletions occur at the 5' end of the subject sequence and therefore, the FASTDB alignment does not show a matched/alignment of the first 10 bases at 5' end. The 10 unpaired bases represent 10% of the sequence (number of bases at the 5' and 3' ends not matched/total number of bases in the query sequence) so 10% is subtracted from the percent identity score calculated by the FASTDB program. If the remaining

90 bases were perfectly matched the final percent identity would be 90%. In another example, a 90 base subject sequence is compared with a 100 base query sequence. This time the deletions are internal deletions so that there are no bases on the 5' or 3' of the subject sequence which are not matched/aligned with the query. In this case the percent identity calculated by FASTDB is not manually corrected. Once again, only bases 5' and 3' of the subject sequence which are not matched/aligned with the query sequence are manually corrected for. No other manual corrections are to be made for the purposes of the present invention.

The KGF-2 variants may contain alterations in the coding regions, non-coding regions, or both. Especially preferred are polynucleotide variants containing alterations which produce silent substitutions, additions, or deletions, but do not alter the properties or activities of the encoded polypeptide. Nucleotide variants produced by silent substitutions due to the degeneracy of the genetic code are preferred. Moreover, variants in which 5-10, 1-5, or 1-2 amino acids are substituted, deleted, or added in any combination are also preferred. KGF-2 polynucleotide variants can be produced for a variety of reasons, e.g., to optimize codon expression for a particular host (change codons in the human mRNA to those preferred by a bacterial host such as *E. coli*).

Alternatively, whether any particular nucleic acid molecule is at least 90%, 95%, 96%, 97%, 98% or 99% identical to, for instance, the nucleotide sequence shown in Figure 1 (SEQ ID NO:1) or to the nucleotides sequence of the deposited cDNA clone may also be determined conventionally using known computer programs such as the Bestfit program (Wisconsin Sequence Analysis Package, Version 8 for Unix, Genetics Computer Group, University Research Park, 575 Science Drive, Madison, WI 53711. Bestfit uses the local homology algorithm of Smith and Waterman, *Advances in Applied Mathematics* 2: 482-489 (1981), to find the best segment of homology between two sequences. When using Bestfit or any other sequence alignment program to determine whether a particular sequence is, for instance, 95% identical to a reference sequence according to the present invention, the parameters are set, of course, such that the

percentage of identity is calculated over the full length of the reference nucleotide sequence and that gaps in homology of up to 5% of the total number of nucleotides in the reference sequence are allowed.

5 The present application is directed to nucleic acid molecules at least 90%, 95%, 96%, 97%, 98% or 99% identical to the nucleic acid sequence shown in Figure 1 [SEQ ID NO:1] or to the nucleic acid sequence of the deposited cDNA, irrespective of whether they encode a polypeptide having KGF-2 activity. This is because even where a particular nucleic acid molecule does not encode a polypeptide having KGF-2 activity, one of skill in the art would still know how
10 to use the nucleic acid molecule, for instance, as a hybridization probe or a polymerase chain reaction (PCR) primer. Uses of the nucleic acid molecules of the present invention that do not encode a polypeptide having KGF-2 activity include, *inter alia*, (1) isolating the KGF-2 gene or allelic variants thereof in a cDNA library; (2) *in situ* hybridization (e.g., "FISH") to metaphase chromosomal
15 spreads to provide precise chromosomal location of the KGF-2 gene, as described in Verma *et al.*, *Human Chromosomes: A Manual of Basic Techniques*, Pergamon Press, New York (1988); and Northern Blot analysis for detecting KGF-2 mRNA expression in specific tissues.

Preferred, however, are nucleic acid molecules having sequences at least
20 90%, 95%, 96%, 97%, 98% or 99% identical to the nucleic acid sequence shown in Figure 1 [SEQ ID NO:1] or to the nucleic acid sequence of the deposited cDNA which do, in fact, encode a polypeptide having KGF-2 protein activity. By "a polypeptide having KGF-2 activity" is intended polypeptides exhibiting activity similar, but not necessarily identical, to an activity of the wild-type KGF-
25 2 protein of the invention or an activity that is enhanced over that of the wild-type KGF-2 protein (either the full-length protein or, preferably, the mature protein), as measured in a particular biological assay.

Assays of KGF-2 activity are disclosed, for example, in the Examples
below. These assays can be used to measure KGF-2 activity of partially purified
30 or purified native or recombinant protein.

5 KGF-2 stimulates the proliferation of epidermal keratinocytes but not mesenchymal cells such as fibroblasts. Thus, "a polypeptide having KGF-2 protein activity" includes polypeptides that exhibit the KGF-2 activity in the keratinocyte proliferation assay set forth in the Examples below and will bind to the FGF receptor isoforms 1-iiiB and 2-iiiB. Although the degree of activity need not be identical to that of the KGF-2 protein, preferably, "a polypeptide having KGF-2 protein activity" will exhibit substantially similar activity as compared to the KGF-2 protein (i.e., the candidate polypeptide will exhibit greater activity or not more than about tenfold less and, preferably, not more than about twofold less activity relative to the reference KGF-2 protein).

10 Of course, due to the degeneracy of the genetic code, one of ordinary skill in the art will immediately recognize that a large number of the nucleic acid molecules having a sequence at least 90%, 95%, 96%, 97%, 98%, or 99% identical to the nucleic acid sequence of the deposited cDNA or the nucleic acid sequence shown in Figure 1 [SEQ ID NO:1] will encode a polypeptide "having KGF-2 protein activity." In fact, since degenerate variants of these nucleotide sequences all encode the same polypeptide, this will be clear to the skilled artisan even without performing the above described comparison assay. It will be further recognized in the art that, for such nucleic acid molecules that are not degenerate variants, a reasonable number will also encode a polypeptide having KGF-2 protein activity. This is because the skilled artisan is fully aware of amino acid substitutions that are either less likely or not likely to significantly effect protein function (e.g., replacing one aliphatic amino acid with a second aliphatic amino acid).

25 For example, guidance concerning how to make phenotypically silent amino acid substitutions is provided in Bowie, J. U. *et al.*, "Deciphering the Message in Protein Sequences: Tolerance to Amino Acid Substitutions," *Science* 247:1306-1310 (1990), wherein the authors indicate that there are two main approaches for studying the tolerance of an amino acid sequence to change. The first method relies on the process of evolution, in which mutations are either

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accepted or rejected by natural selection. The second approach uses genetic engineering to introduce amino acid changes at specific positions of a cloned gene and selections or screens to identify sequences that maintain functionality. As the authors state, these studies have revealed that proteins are surprisingly tolerant of amino acid substitutions. The authors further indicate which amino acid changes are likely to be permissive at a certain position of the protein. For example, most buried amino acid residues require nonpolar side chains, whereas few features of surface side chains are generally conserved. Other such phenotypically silent substitutions are described in Bowie, J.U. *et al.*, *supra*, and the references cited therein.

The present invention further relates to polynucleotides which hybridize to the hereinabove-described sequences if there is at least 70%, preferably at least 90%, and more preferably at least 95% and still more preferably 96%, 97%, 98%, 99% identity between the sequences. The present invention particularly relates to polynucleotides which hybridize under stringent conditions to the hereinabove-described polynucleotides. As herein used, the term "stringent conditions" means hybridization will occur only if there is at least 95% and preferably at least 97% identity between the sequences. The polynucleotides which hybridize to the hereinabove described polynucleotides in a preferred embodiment encode polypeptides which either retain substantially the same biological function or activity as the mature polypeptide encoded by the cDNAs of Figure 1 (SEQ ID NO:1) or the deposited cDNA(s).

An example of "stringent hybridization conditions" includes overnight incubation at 42°C in a solution comprising: 50% formamide, 5x SSC (750 mM NaCl, 75mM trisodium citrate), 50 mM sodium phosphate (pH 7.6), 5x Denhardt's solution, 10% dextran sulfate, and 20 µg/ml denatured, sheared salmon sperm DNA, followed by washing the filters in 0.1x SSC at about 65°C.

Alternatively, the polynucleotide may have at least 20 bases, preferably 30 bases, and more preferably at least 50 bases which hybridize to a polynucleotide of the present invention and which has an identity thereto, as

hereinabove described, and which may or may not retain activity. For example, such polynucleotides may be employed as probes for the polynucleotide of SEQ ID NO:1, for example, for recovery of the polynucleotide or as a diagnostic probe or as a PCR primer.

5 Of course, polynucleotides hybridizing to a larger portion of the reference polynucleotide (e.g., the deposited cDNA clone), for instance, a portion 50, 75, 100, 125, 150, 175, 200, 225, 250, 275, 300, 325, 350, 375, 400, 425, 450, 475, 500, 525, 550, 575, 600, 625, 650, 675, 700, 725, or 750 nt in length, or even to the entire length of the reference polynucleotide, are also useful as probes
10 according to the present invention, as are polynucleotides corresponding to most, if not all, of the nucleotide sequence of the deposited cDNA or the nucleotide sequence as shown in Figure 1 [SEQ ID NO:1]. By a portion of a polynucleotide of "at least 20 nt in length," for example, is intended 20 or more contiguous nucleotides from the nucleotide sequence of the reference polynucleotide (e.g.,
15 the deposited cDNA or the nucleotide sequence as shown in Figure 1 [SEQ ID NO:1]). As indicated, such portions are useful diagnostically either as a probe according to conventional DNA hybridization techniques or as primers for amplification of a target sequence by the polymerase chain reaction (PCR), as described, for instance, in *Molecular Cloning, A Laboratory Manual*, 2nd.
20 edition, edited by Sambrook, J., Fritsch, E. F. and Maniatis, T., (1989), Cold Spring Harbor Laboratory Press, the entire disclosure of which is hereby incorporated herein by reference.

 Since a KGF-2 cDNA clone has been deposited and its determined nucleotide sequence is provided in Figure 1 [SEQ ID NO:1], generating
25 polynucleotides which hybridize to a portion of the KGF-2 cDNA molecule would be routine to the skilled artisan. For example, restriction endonuclease cleavage or shearing by sonication of the KGF-2 cDNA clone could easily be used to generate DNA portions of various sizes which are polynucleotides that hybridize to a portion of the KGF-2 cDNA molecule. Alternatively, the
30 hybridizing polynucleotides of the present invention could be generated

synthetically according to known techniques. Of course, a polynucleotide which hybridizes only to a poly A sequence (such as the 3' terminal poly(A) tract of the KGF-2 cDNA shown in Figure 1 [SEQ ID NO:1]), or to a complementary stretch of T (or U) residues, would not be included in a polynucleotide of the invention used to hybridize to a portion of a nucleic acid of the invention, since such a polynucleotide would hybridize to any nucleic acid molecule containing a poly (A) stretch or the complement thereof (e.g., practically any double-stranded cDNA clone).

The invention further provides isolated nucleic acid molecules comprising a polynucleotide encoding an epitope-bearing portion of the KGF-2 protein. In particular, isolated nucleic acid molecules are provided encoding polypeptides comprising the following amino acid residues in Figure 1 (SEQ ID NO:2), which the present inventors have determined are antigenic regions of the KGF-2 protein:

1. Gly41-Asn71: GQDMVSPEATNSSSSSFSSPSSAGRHVRSYN [SEQ ID NO:25];
2. Lys91-Ser109: KIEKNGKVSGTKKENCYPYS [SEQ ID NO:26];
3. Asn135-Tyr164: NKKGKLYGSKEFNNDCKLKERIEENGYNTY [SEQ ID NO 27]; and
4. Asn181-Ala199: NGKGAPRRGQKTRRKNTSA [SEQ ID NO:28].

Also, there are two additional shorter predicted antigenic areas, Gln74-Arg78 of Figure 1 (SEQ ID NO:2) and Gln170-Gln175 of Figure 1 (SEQ ID NO:2). Methods for generating such epitope-bearing portions of KGF-2 are described in detail below.

The deposit(s) referred to herein will be maintained under the terms of the Budapest Treaty on the International Recognition of the Deposit of Micro-organisms for purposes of Patent Procedure. These deposits are provided merely as convenience to those of skill in the art and are not an admission that a deposit is required under 35 U.S.C. § 112. The sequence of the polynucleotides contained in the deposited materials, as well as the amino acid sequence of the polypeptides encoded thereby, are incorporated herein by reference and are

controlling in the event of any conflict with any description of sequences herein. A license may be required to make, use or sell the deposited materials, and no such license is hereby granted.

KGF-2 Polypeptides and Fragments

5 The present invention further relates to a polypeptide which has the deduced amino acid sequence of Figure 1 (SEQ ID NO:2) or which has the amino acid sequence encoded by the deposited cDNA, as well as fragments, analogs and derivatives of such polypeptide.

10 As one of ordinary skill would appreciate, due to the possibilities of sequencing errors discussed above, as well as the variability of cleavage sites for leaders in different known proteins, the actual KGF-2 polypeptide encoded by the deposited cDNA comprises about 208 amino acids, but may be anywhere in the range of 200-220 amino acids; and the actual leader sequence of this protein is about 35 or 36 amino acids, but may be anywhere in the range of about 30 to
15 about 40 amino acids.

 The terms "fragment," "derivative" and "analog" when referring to the polypeptide, of Figure 1 (SEQ ID NO:2) or that encoded by the deposited cDNA, means a polypeptide which retains essentially the same biological function or activity as such polypeptide. Thus, an analog includes a protein which can be
20 activated by cleavage of the protein portion to produce an active mature polypeptide.

 The polypeptide of the present invention may be a recombinant polypeptide, a natural polypeptide or a synthetic polypeptide, preferably a recombinant polypeptide.

25 The fragment, derivative or analog of the polypeptide of Figure 1 (SEQ ID NO:2) or that encoded by the deposited cDNA may be (i) one in which one or more of the amino acid residues are substituted with a conserved or non-conserved amino acid residue (preferably a conserved amino acid residue) and

such substituted amino acid residue may or may not be one encoded by the genetic code, or (ii) one in which one or more of the amino acid residues includes a substituent group, or (iii) one in which the mature polypeptide is fused with another compound, such as a compound to increase the half-life of the polypeptide (for example, polyethylene glycol), or (iv) one in which the additional amino acids are fused to the mature polypeptide, such as a leader or secretary sequence or a sequence which is employed for purification of the mature polypeptide or a protein sequence. Such fragments, derivatives and analogs are deemed to be within the scope of those skilled in the art from the teachings herein.

The terms "peptide" and "oligopeptide" are considered synonymous (as is commonly recognized) and each term can be used interchangeably as the context requires to indicate a chain of at least two amino acids coupled by peptidyl linkages. The word "polypeptide" is used herein for chains containing more than ten amino acid residues. All oligopeptide and polypeptide formulas or sequences herein are written from left to right and in the direction from amino terminus to carboxy terminus.

It will be recognized in the art that some amino acid sequences of the KGF-2 polypeptide can be varied without significant effect of the structure or function of the protein. If such differences in sequence are contemplated, it should be remembered that there will be critical areas on the protein which determine activity. In general, it is possible to replace residues which form the tertiary structure, provided that residues performing a similar function are used. In other instances, the type of residue may be completely unimportant if the alteration occurs at a non-critical region of the protein.

Thus, the invention further includes variations of the KGF-2 polypeptide which show substantial KGF-2 polypeptide activity or which include regions of KGF-2 protein such as the protein portions discussed below. Such mutants include deletions, insertions, inversions, repeats, and type substitutions (for example, substituting one hydrophilic residue for another, but not strongly

hydrophilic for strongly hydrophobic as a rule). Small changes or such "neutral" amino acid substitutions will generally have little effect on activity.

Typically seen as conservative substitutions are the replacements, one for another, among the aliphatic amino acids Ala, Val, Leu and Ile; interchange of the hydroxyl residues Ser and Thr, exchange of the acidic residues Asp and Glu, substitution between the amide residues Asn and Gln, exchange of the basic residues Lys and Arg and replacements among the aromatic residues Phe, Tyr.

As indicated in detail above, further guidance concerning which amino acid changes are likely to be phenotypically silent (i.e., are not likely to have a significant deleterious effect on a function) can be found in Bowie, J.U., *et al.*, "Deciphering the Message in Protein Sequences: Tolerance to Amino Acid Substitutions," *Science* 247:1306-1310 (1990).

The present invention includes mimetic peptides of KGF-2 which can be used as therapeutic peptides. Mimetic KGF-2 peptides are short peptides which mimic the biological activity of the KGF-2 protein by binding to and activating the cognate receptors of KGF-2. Mimetic KGF-2 peptides can also bind to and inhibit the cognate receptors of KGF-2. KGF-2 receptors include, but are not limited to, FGFR2iiib and FGFR1iiib. Such mimetic peptides are obtained from methods such as, but not limited to, phage display or combinatorial chemistry. For example, the method disclosed by Wrighton et al. *Science* 273:458-463 (1996) can be used to generate mimetic KGF-2 peptides.

The polypeptides and polynucleotides of the present invention are preferably provided in an isolated form, and preferably are purified to homogeneity.

The polypeptides of the present invention are preferably in an isolated form. By "isolated polypeptide" is intended a polypeptide removed from its native environment. Thus, a polypeptide produced and/or contained within a recombinant host cell is considered isolated for purposes of the present invention. Also intended are polypeptides that have been purified, partially or substantially, from a recombinant host cell or a native source.

The polypeptides of the present invention include the polypeptide of SEQ ID NO:2 (in particular the mature polypeptide) as well as polypeptides which have at least 90%, 95%, 96%, 97%, 98%, 99% similarity (more preferably at least 90%, 95%, 96%, 97%, 98%, 99% identity) to the polypeptide of SEQ ID NO:2 and also include portions of such polypeptides with such portion of the polypeptide (such as the deletion mutants described below) generally containing at least 30 amino acids and more preferably at least 50 amino acids.

As known in the art "similarity" between two polypeptides is determined by comparing the amino acid sequence and its conserved amino acid substitutes of one polypeptide to the sequence of a second polypeptide.

By "% similarity" for two polypeptides is intended a similarity score produced by comparing the amino acid sequences of the two polypeptides using the Bestfit program (Wisconsin Sequence Analysis Package, Version 8 for Unix, Genetics Computer Group, University Research Park, 575 Science Drive, Madison, WI 53711) and the default settings for determining similarity. Bestfit uses the local homology algorithm of Smith and Waterman (*Advances in Applied Mathematics* 2: 482-489, 1981) to find the best segment of similarity between two sequences.

By a polypeptide having an amino acid sequence at least, for example, 95% "identical" to a reference amino acid sequence of a KGF-2 polypeptide is intended that the amino acid sequence of the polypeptide is identical to the reference sequence except that the polypeptide sequence may include up to five amino acid alterations per each 100 amino acids of the reference amino acid of the KGF-2 polypeptide. In other words, to obtain a polypeptide having an amino acid sequence at least 95% identical to a reference amino acid sequence, up to 5% of the amino acid residues in the reference sequence may be deleted or substituted with another amino acid, or a number of amino acids up to 5% of the total amino acid residues in the reference sequence may be inserted into the reference sequence. These alterations of the reference sequence may occur at the amino or carboxy terminal positions of the reference amino acid sequence or anywhere

between those terminal positions, interspersed either individually among residues in the reference sequence or in one or more contiguous groups within the reference sequence.

5 By a polypeptide having an amino acid sequence at least, for example, 95% "identical" to a query amino acid sequence of the present invention, it is intended that the amino acid sequence of the subject polypeptide is identical to the query sequence except that the subject polypeptide sequence may include up to five amino acid alterations per each 100 amino acids of the query amino acid sequence. In other words, to obtain a polypeptide having an amino acid sequence
10 at least 95% identical to a query amino acid sequence, up to 5% of the amino acid residues in the subject sequence may be inserted, deleted, (indels) or substituted with another amino acid. These alterations of the reference sequence may occur at the amino or carboxy terminal positions of the reference amino acid sequence or anywhere between those terminal positions, interspersed either individually
15 among residues in the reference sequence or in one or more contiguous groups within the reference sequence.

As a practical matter, whether any particular polypeptide is at least 90%, 95%, 96%, 97%, 98% or 99% identical to, for instance, the amino acid sequences shown in SEQ ID NO:2 or to the amino acid sequence encoded by deposited
20 DNA clone can be determined conventionally using known computer programs. A preferred method for determining the best overall match between a query sequence (a sequence of the present invention) and a subject sequence, also referred to as a global sequence alignment, can be determined using the FASTDB computer program based on the algorithm of Brutlag et al. (Comp. App. Biosci.
25 (1990) 6:237-245). In a sequence alignment the query and subject sequences are either both nucleotide sequences or both amino acid sequences. The result of said global sequence alignment is in percent identity. Preferred parameters used in a FASTDB amino acid alignment are: Matrix=PAM 0, k-tuple=2, Mismatch Penalty=1, Joining Penalty=20, Randomization Group Length=0, Cutoff Score=1,
30 Window Size=sequence length, Gap Penalty=5, Gap Size Penalty=0.05, Window

Size=500 or the length of the subject amino acid sequence, whichever is shorter. If the subject sequence is shorter than the query sequence due to N- or C-terminal deletions, not because of internal deletions, a manual correction must be made to the results. This is because the FASTDB program does not account for N- and C-terminal truncations of the subject sequence when calculating global percent identity. For subject sequences truncated at the N- and C-termini, relative to the query sequence, the percent identity is corrected by calculating the number of residues of the query sequence that are N- and C-terminal of the subject sequence, which are not matched/aligned with a corresponding subject residue, as a percent of the total bases of the query sequence. Whether a residue is matched/aligned is determined by results of the FASTDB sequence alignment. This percentage is then subtracted from the percent identity, calculated by the above FASTDB program using the specified parameters, to arrive at a final percent identity score. This final percent identity score is what is used for the purposes of the present invention. Only residues to the N- and C-termini of the subject sequence, which are not matched/aligned with the query sequence, are considered for the purposes of manually adjusting the percent identity score. That is, only query residue positions outside the farthest N- and C-terminal residues of the subject sequence.

For example, a 90 amino acid residue subject sequence is aligned with a 100 residue query sequence to determine percent identity. The deletion occurs at the N-terminus of the subject sequence and therefore, the FASTDB alignment does not show a matching/alignment of the first 10 residues at the N-terminus. The 10 unpaired residues represent 10% of the sequence (number of residues at the N- and C- termini not matched/total number of residues in the query sequence) so 10% is subtracted from the percent identity score calculated by the FASTDB program. If the remaining 90 residues were perfectly matched the final percent identity would be 90%. In another example, a 90 residue subject sequence is compared with a 100 residue query sequence. This time the deletions are internal deletions so there are no residues at the N- or C-termini of the subject sequence which are not matched/aligned with the query. In this case the percent

identity calculated by FASTDB is not manually corrected. Once again, only residue positions outside the N- and C-terminal ends of the subject sequence, as displayed in the FASTDB alignment, which are not matched/aligned with the query sequence are manually corrected for. No other manual corrections are to
5 made for the purposes of the present invention.

Alternatively, whether any particular polypeptide is at least 90%, 95%, 96%, 97%, 98% or 99% identical to, for instance, the amino acid sequence shown in Figure 1 [SEQ ID NO:2] or to the amino acid sequence encoded by deposited cDNA clone may also be determined conventionally using known computer
10 programs such the Bestfit program (Wisconsin Sequence Analysis Package, Version 8 for Unix, Genetics Computer Group, University Research Park, 575 Science Drive, Madison, WI 53711. When using Bestfit or any other sequence alignment program to determine whether a particular sequence is, for instance, 95% identical to a reference sequence according to the present invention, the
15 parameters are set, of course, such that the percentage of identity is calculated over the full length of the reference amino acid sequence and that gaps in homology of up to 5% of the total number of amino acid residues in the reference sequence are allowed.

As described in detail below, the polypeptides of the present invention can
20 be used to raise polyclonal and monoclonal antibodies, which are useful in diagnostic assays for detecting KGF-2 protein expression as described below or as agonists and antagonists capable of enhancing or inhibiting KGF-2 protein function. Further, such polypeptides can be used in the yeast two-hybrid system to "capture" KGF-2 protein binding proteins which are also candidate agonist and
25 antagonist according to the present invention. The yeast two hybrid system is described in Fields and Song, *Nature* 340:245-246 (1989).

In another aspect, the invention provides a peptide or polypeptide comprising an epitope-bearing portion of a polypeptide of the invention. The epitope of this polypeptide portion is an immunogenic or antigenic epitope of a
30 polypeptide of the invention. An "immunogenic epitope" is defined as a part of

a protein that elicits an antibody response when the whole protein is the immunogen. These immunogenic epitopes are believed to be confined to a few loci on the molecule. On the other hand, a region of a protein molecule to which an antibody can bind is defined as an "antigenic epitope." The number of immunogenic epitopes of a protein generally is less than the number of antigenic epitopes. See, for instance, Geysen *et al.*, *Proc. Natl. Acad. Sci. USA* 81:3998-4002 (1983).

As to the selection of peptides or polypeptides bearing an antigenic epitope (i.e., that contain a region of a protein molecule to which an antibody can bind), it is well known in that art that relatively short synthetic peptides that mimic part of a protein sequence are routinely capable of eliciting an antiserum that reacts with the partially mimicked protein. See, for instance, Sutcliffe, J. G., Shinnick, T. M., Green, N. and Learner, R. A. (1983) Antibodies that react with predetermined sites on proteins. *Science* 219:660-666. Peptides capable of eliciting protein-reactive sera are frequently represented in the primary sequence of a protein, can be characterized by a set of simple chemical rules, and are confined neither to immunodominant regions of intact proteins (i.e., immunogenic epitopes) nor to the amino or carboxyl terminals. Peptides that are extremely hydrophobic and those of six or fewer residues generally are ineffective at inducing antibodies that bind to the mimicked protein; longer, soluble peptides, especially those containing proline residues, usually are effective. Sutcliffe *et al.*, *supra*, at 661. For instance, 18 of 20 peptides designed according to these guidelines, containing 8-39 residues covering 75% of the sequence of the influenza virus hemagglutinin HA1 polypeptide chain, induced antibodies that reacted with the HA1 protein or intact virus; and 12/12 peptides from the MuLV polymerase and 18/18 from the rabies glycoprotein induced antibodies that precipitated the respective proteins.

Antigenic epitope-bearing peptides and polypeptides of the invention are therefore useful to raise antibodies, including monoclonal antibodies, that bind specifically to a polypeptide of the invention. Thus, a high proportion of

hybridomas obtained by fusion of spleen cells from donors immunized with an antigen epitope-bearing peptide generally secrete antibody reactive with the native protein. Sutcliffe et al., *supra*, at 663. The antibodies raised by antigenic epitope-bearing peptides or polypeptides are useful to detect the mimicked protein, and antibodies to different peptides may be used for tracking the fate of various regions of a protein precursor which undergoes post-translational processing. The peptides and anti-peptide antibodies may be used in a variety of qualitative or quantitative assays for the mimicked protein, for instance in competition assays since it has been shown that even short peptides (e.g., about 9 amino acids) can bind and displace the larger peptides in immunoprecipitation assays. See, for instance, Wilson *et al.*, *Cell* 37:767-778 (1984) at 777. The anti-peptide antibodies of the invention also are useful for purification of the mimicked protein, for instance, by adsorption chromatography using methods well known in the art.

Antigenic epitope-bearing peptides and polypeptides of the invention designed according to the above guidelines preferably contain a sequence of at least seven, more preferably at least nine and most preferably between about 15 to about 30 amino acids contained within the amino acid sequence of a polypeptide of the invention. However, peptides or polypeptides comprising a larger portion of an amino acid sequence of a polypeptide of the invention, containing about 30, 40, 50, 60, 70, 80, 90, 100, or 150 amino acids, or any length up to and including the entire amino acid sequence of a polypeptide of the invention, also are considered epitope-bearing peptides or polypeptides of the invention and also are useful for inducing antibodies that react with the mimicked protein. Preferably, the amino acid sequence of the epitope-bearing peptide is selected to provide substantial solubility in aqueous solvents (i.e., the sequence includes relatively hydrophilic residues and highly hydrophobic sequences are preferably avoided); and sequences containing proline residues are particularly preferred.

Non-limiting examples of antigenic polypeptides or peptides that can be

used to generate KGF-2-specific antibodies include the following:

1. Gly41-Asn71: QQDMVSPEATNSSSSSFSSPSSAGRHVRSYN [SEQ ID NO:25];
2. Lys91-Ser109: KIEKNGKVSGTKKENCYPYS [SEQ ID NO:26];
- 5 3. Asn135-Tyr164: NKKGKLYGSKEFNNDCKLKERIEENGYNTY [SEQ ID NO: 27]; and
4. Asn181-Ala199: NGKGAPRRGQKTRRKNTSA [SEQ ID NO:28].

Also, there are two additional shorter predicted antigenic areas, Gln74-Arg78 of Figure 1 (SEQ ID NO:2) and Gln170-Gln175 of Figure 1 (SEQ ID NO:2).

10 The epitope-bearing peptides and polypeptides of the invention may be produced by any conventional means for making peptides or polypeptides including recombinant means using nucleic acid molecules of the invention. For instance, a short epitope-bearing amino acid sequence may be fused to a larger polypeptide which acts as a carrier during recombinant production and

15 purification, as well as during immunization to produce anti-peptide antibodies. Epitope-bearing peptides also may be synthesized using known methods of chemical synthesis. For instance, Houghten has described a simple method for synthesis of large numbers of peptides, such as 10-20 mg of 248 different 13 residue peptides representing single amino acid variants of a segment of the HA1

20 polypeptide which were prepared and characterized (by ELISA-type binding studies) in less than four weeks. Houghten, R. A. (1985) General method for the rapid solid-phase synthesis of large numbers of peptides: specificity of antigen-antibody interaction at the level of individual amino acids. *Proc. Natl. Acad. Sci. USA* 82:5131-5135. This "Simultaneous Multiple Peptide Synthesis (SMPS)" process is further described in U.S. Patent No. 4,631,211 to Houghten

25 et al. (1986). In this procedure the individual resins for the solid-phase synthesis of various peptides are contained in separate solvent-permeable packets, enabling the optimal use of the many identical repetitive steps involved in solid-phase methods. A completely manual procedure allows 500-1000 or more syntheses to

30 be conducted simultaneously. Houghten et al., *supra*, at 5134.

Epitope-bearing peptides and polypeptides of the invention are used to induce antibodies according to methods well known in the art. See, for instance, Sutcliffe et al., *supra*; Wilson et al., *supra*; Chow, M. et al., *Proc. Natl. Acad. Sci. USA* 82:910-914; and Bittle, F. J. et al., *J. Gen. Virol.* 66:2347-2354 (1985).

5 Generally, animals may be immunized with free peptide; however, anti-peptide antibody titer may be boosted by coupling of the peptide to a macromolecular carrier, such as keyhole limpet hemacyanin (KLH) or tetanus toxoid. For instance, peptides containing cysteine may be coupled to carrier using a linker such as m-maleimidobenzoyl-N-hydroxysuccinimide ester (MBS), while other
10 peptides may be coupled to carrier using a more general linking agent such as glutaraldehyde. Animals such as rabbits, rats and mice are immunized with either free or carrier-coupled peptides, for instance, by intraperitoneal and/or intradermal injection of emulsions containing about 100 µg peptide or carrier protein and Freund's adjuvant. Several booster injections may be needed, for
15 instance, at intervals of about two weeks, to provide a useful titer of anti-peptide antibody which can be detected, for example, by ELISA assay using free peptide adsorbed to a solid surface. The titer of anti-peptide antibodies in serum from an immunized animal may be increased by selection of anti-peptide antibodies, for instance, by adsorption to the peptide on a solid support and elution of the
20 selected antibodies according to methods well known in the art.

Immunogenic epitope-bearing peptides of the invention, i.e., those parts of a protein that elicit an antibody response when the whole protein is the immunogen, are identified according to methods known in the art. For instance, Geysen et al., *supra*, discloses a procedure for rapid concurrent synthesis on solid
25 supports of hundreds of peptides of sufficient purity to react in an enzyme-linked immunosorbent assay. Interaction of synthesized peptides with antibodies is then easily detected without removing them from the support. In this manner a peptide bearing an immunogenic epitope of a desired protein may be identified routinely by one of ordinary skill in the art. For instance, the immunologically important
30 epitope in the coat protein of foot-and-mouth disease virus was located by Geysen

et al. with a resolution of seven amino acids by synthesis of an overlapping set of all 208 possible hexapeptides covering the entire 213 amino acid sequence of the protein. Then, a complete replacement set of peptides in which all 20 amino acids were substituted in turn at every position within the epitope were synthesized, and the particular amino acids conferring specificity for the reaction with antibody were determined. Thus, peptide analogs of the epitope-bearing peptides of the invention can be made routinely by this method. U.S. Patent No. 4,708,781 to Geysen (1987) further describes this method of identifying a peptide bearing an immunogenic epitope of a desired protein.

Further still, U.S. Patent No. 5,194,392 to Geysen (1990) describes a general method of detecting or determining the sequence of monomers (amino acids or other compounds) which is a topological equivalent of the epitope (i.e., a "mimotope") which is complementary to a particular paratope (antigen binding site) of an antibody of interest. More generally, U.S. Patent No. 4,433,092 to Geysen (1989) describes a method of detecting or determining a sequence of monomers which is a topographical equivalent of a ligand which is complementary to the ligand binding site of a particular receptor of interest. Similarly, U.S. Patent No. 5,480,971 to Houghten, R. A. *et al.* (1996) on Peralkylated Oligopeptide Mixtures discloses linear C₁-C₇-alkyl peralkylated oligopeptides and sets and libraries of such peptides, as well as methods for using such oligopeptide sets and libraries for determining the sequence of a peralkylated oligopeptide that preferentially binds to an acceptor molecule of interest. Thus, non-peptide analogs of the epitope-bearing peptides of the invention also can be made routinely by these methods.

As one of skill in the art will appreciate, KGF-2 polypeptides of the present invention and the epitope-bearing fragments thereof described above can be combined with parts of the constant domain of immunoglobulins (IgG), resulting in chimeric polypeptides. These fusion proteins facilitate purification and show an increased half-life *in vivo*. This has been shown, e.g., for chimeric proteins consisting of the first two domains of the human CD4-polypeptide and

various domains of the constant regions of the heavy or light chains of mammalian immunoglobulins (EPA 394,827; Traunecker *et al.*, *Nature* 331:84-86 (1988)). Fusion proteins that have a disulfide-linked dimeric structure due to the IgG part can also be more efficient in binding and neutralizing other molecules than the monomeric KGF-2 protein or protein fragment alone (Fountoulakis *et al.*, *J Biochem* 270:3958-3964 (1995)).

In accordance with the present invention, novel variants of KGF-2 are also described. These can be produced by deleting or substituting one or more amino acids of KGF-2. Natural mutations are called allelic variations. Allelic variations can be silent (no change in the encoded polypeptide) or may have altered amino acid sequence.

In order to attempt to improve or alter the characteristics of native KGF-2, protein engineering may be employed. Recombinant DNA technology known to those skilled in the art can be used to create novel polypeptides. Muteins and deletions can show, e.g., enhanced activity or increased stability. In addition, they could be purified in higher yield and show better solubility at least under certain purification and storage conditions. Set forth below are examples of mutations that can be constructed.

Amino terminal and carboxy terminal deletions

Various members of the FGF family have been modified using recombinant DNA technology. Positively charged molecules have been substituted or deleted in both aFGF and bFGF that are important for heparin binding. The modified molecules resulted in reduced heparin binding activity. Accordingly, it is known that the amount of modified molecule sequestered by heparin in a patient would be reduced, increasing the potency as more FGF would reach the appropriate receptor. (EP 0 298 723).

Native KGF-2 is relatively unstable in the aqueous state and it undergoes chemical and physical degradation resulting in loss of biological activity during

processing and storage. Native KGF-2 is also prone to aggregation in aqueous solution, at elevated temperatures and it becomes inactivated under acidic conditions.

In order to improve or alter one or more characteristics of native KGF-2, protein engineering may be employed. Ron *et al.*, *J. Biol. Chem.*, 268(4): 2984-2988 (1993) reported modified KGF proteins that had heparin binding activity even if the 3, 8, or 27 amino terminal amino acid residues were missing. The deletion of 3 and 8 amino acids had full activity. More deletions of KGF have been described in PCT/IB95/00971. The deletion of carboxyterminal amino acids can enhance the activity of proteins. One example is interferon gamma that shows up to ten times higher activity by deleting ten amino acid residues from the carboxy terminus of the protein (Döbeli *et al.*, *J. of Biotechnology* 7:199-216 (1988)). Thus, one aspect of the invention is to provide polypeptide analogs of KGF-2 and nucleotide sequences encoding such analogs that exhibit enhanced stability (e.g., when exposed to typical pH, thermal conditions or other storage conditions) relative to the native KGF-2 polypeptide.

Particularly preferred KGF-2 polypeptides are shown below (numbering starts with the first amino acid in the protein (Met) (Figure 1 (SEQ ID NO:2))):

	Thr (residue 36) -- Ser (residue 208)	Asn (51) -- Ser (208)
20	Cys (37) -- Ser (208)	Ser (52) -- Ser (208)
	Gln (38) -- Ser (208)	Ser (53) -- Ser (208)
	Ala (39) -- Ser (208)	Ser (54) -- Ser (208)
	Leu (40) -- Ser (208)	Ser (55) -- Ser (208)
	Gly (41) -- Ser (208)	Ser (56) -- Ser (208)
25	Gln (42) -- Ser (208)	Phe (57) -- Ser (208)
	Asp (43) -- Ser (208)	Ser (59) -- Ser (208)
	Met (44) -- Ser (208)	Ser (62) -- Ser (208)
	Val (45) -- Ser (208)	Ala (63) -- Ser (208)
	Ser (46) -- Ser (208)	Gly (64) -- Ser (208)
30	Pro (47) -- Ser (208)	Arg (65) -- Ser (208)
	Glu (48) -- Ser (208)	Val (67) -- Ser (208)
	Ala (49) -- Ser (208)	Ser (69) -- Ser (208)
	Thr (50) -- Ser (208)	Val (77) -- Ser (208)

Arg (80) -- Ser (208)
 Met(1), Thr (36), or Cys (37) -- His (207)
 Met (1), Thr (36), or Cys (37) -- Val (206)
 Met (1), Thr (36), or Cys (37) -- Val (205)
 5 Met(1), Thr (36), or Cys (37) -- Met (204)
 Met(1), Thr (36), or Cys (37) -- Pro (203)
 Met(1), Thr (36), or Cys(37) -- Leu (202)
 Met(1), Thr (36), or Cys (37) -- Phe (201)
 Met(1), Thr (36), or Cys (37) -- His (200)
 10 Met(1), Thr (36), or Cys (37) -- Ala (199)
 Met (1), Thr (36), or Cys (37) -- Ser (198)
 Met (1), Thr (36), or Cys (37) -- Thr (197)
 Met(1), Thr (36), or Cys (37) --Asn (196)
 Met(1), Thr (36), or Cys (37) -- Lys (195)
 15 Met (1), Thr (36), or Cys (37) -- Arg (194)
 Met(1), Thr (36), or Cys (37) -- Arg (193)
 Met(1), Thr (36), or Cys (37) -- Thr (192)
 Met(1), Thr (36), or Cys (37) -- Lys (191)
 Met(1), Thr (36), or Cys (37) -- Arg (188)
 20 Met(1), Thr (36), or Cys (37) -- Arg (187)
 Met(1), Thr (36), or Cys (37) -- Lys (183)

Preferred embodiments include the N-terminal deletions Ala (63) -- Ser (208) (KGF-2Δ28) (SEQ ID NO:68) and Ser (69) -- Ser (208) (KGF-2Δ33) (SEQ ID NO:96). Other preferred N-terminal and C-terminal deletion mutants are

25 described in Examples 13 and 16 (c) of the specification and include: Ala (39) -- Ser (208) (SEQ ID NO:116); Pro (47) -- Ser (208) of Figure 1 (SEQ ID NO:2); Val (77) -- Ser (208) (SEQ ID NO:70); Glu (93) -- Ser (208) (SEQ ID NO:72); Glu (104) -- Ser (208) (SEQ ID NO:74); Val (123) - Ser (208) (SEQ ID NO:76); and Gly (138) -- Ser (208) (SEQ ID NO:78). Other preferred C-terminal deletion

30 mutants include: Met (1), Thr (36), or Cys (37) -- Lys (153) of Figure 1 (SEQ ID NO:2).

Also included by the present invention are deletion mutants having amino acids deleted from both the N- terminus and the C-terminus. Such mutants

include all combinations of the N-terminal deletion mutants and C-terminal deletion mutants described above, e.g., Ala (39) -- His (200) of Figure 1 (SEQ ID NO:2), Met (44) -- Arg (193) of Figure 1 (SEQ ID NO:2), Ala (63) -- Lys (153) of Figure 1 (SEQ ID NO:2), Ser (69) - Lys (153) of Figure 1 (SEQ ID NO:2), etc.
5 etc. etc Those combinations can be made using recombinant techniques known to those skilled in the art.

Thus, in one aspect, N-terminal deletion mutants are provided by the present invention. Such mutants include those comprising the amino acid sequence shown in Figure 1 (SEQ ID NO:2) except for a deletion of at least the
10 first 38 N-terminal amino acid residues (i.e., a deletion of at least Met (1) -- Gln (38)) but not more than the first 147 N-terminal amino acid residues of Figure 1 (SEQ ID NO:2). Alternatively, the deletion will include at least the first 38 N-terminal amino acid residues (i.e., a deletion of at least Met (1) -- Gln (38)) but not more than the first 137 N-terminal amino acid residues of Figure 1 (SEQ ID
15 NO:2). Alternatively, the deletion will include at least the first 46 N-terminal amino acid residues but not more than the first 137 N-terminal amino acid residues of Figure 1 (SEQ ID NO:2). Alternatively, the deletion will include at least the first 62 N-terminal amino acid residues but not more than the first 137 N-terminal amino acid residues of Figure 1 (SEQ ID NO:2). Alternatively, the
20 deletion will include at least the first 68 N-terminal amino acid residues but not more than the first 137 N-terminal amino acid residues of Figure 1 (SEQ ID NO:2). Alternatively, the deletion will include at least the first 76 N-terminal amino acid residues but not more than the first 137 N-terminal amino acid residues of Figure 1 (SEQ ID NO:2). Alternatively, the deletion will include at
25 least the first 92 N-terminal amino acid residues but not more than the first 137 N-terminal amino acid residues of Figure 1 (SEQ ID NO:2). Alternatively, the deletion will include at least the first 103 N-terminal amino acid residues but not more than the first 137 N-terminal amino acid residues of Figure 1 (SEQ ID NO:2). Alternatively, the deletion will include at least the first 122 N-terminal
30 amino acid residues but not more than the first 137 N-terminal amino acid

residues of Figure 1 (SEQ ID NO:2).

In addition to the ranges of N-terminal deletion mutants described above, the present invention is also directed to all combinations of the above described ranges, e.g., deletions of at least the first 62 N-terminal amino acid residues but not more than the first 68 N-terminal amino acid residues of Figure 1 (SEQ ID NO:2); deletions of at least the first 62 N-terminal amino acid residues but not more than the first 76 N-terminal amino acid residues of Figure 1 (SEQ ID NO:2); deletions of at least the first 62 N-terminal amino acid residues but not more than the first 92 N-terminal amino acid residues of Figure 1 (SEQ ID NO:2); deletions of at least the first 62 N-terminal amino acid residues but not more than the first 103 N-terminal amino acid residues of Figure 1 (SEQ ID NO:2); deletions of at least the first 68 N-terminal amino acid residues but not more than the first 76 N-terminal amino acid residues of Figure 1 (SEQ ID NO:2); deletions of at least the first 68 N-terminal amino acid residues but not more than the first 92 N-terminal amino acid residues of Figure 1 (SEQ ID NO:2); deletions of at least the first 68 N-terminal amino acid residues but not more than the first 103 N-terminal amino acid residues of Figure 1 (SEQ ID NO:2); deletions of at least the first 46 N-terminal amino acid residues but not more than the first 62 N-terminal amino acid residues of Figure 1 (SEQ ID NO:2); deletions of at least the first 46 N-terminal amino acid residues but not more than the first 68 N-terminal amino acid residues of Figure 1 (SEQ ID NO:2); deletions of at least the first 46 N-terminal amino acid residues but not more than the first 76 N-terminal amino acid residues of Figure 1 (SEQ ID NO:2); etc. etc. etc. . . .

In another aspect, C-terminal deletion mutants are provided by the present invention. Preferably, the N-terminal amino acid residue of said C-terminal deletion mutants is amino acid residue 1 (Met), 36 (Thr), or 37 (Cys) of Figure 1 (SEQ ID NO:2). Such mutants include those comprising the amino acid sequence shown in Figure 1 (SEQ ID NO:2) except for a deletion of at least the last C-terminal amino acid residue (Ser (208)) but not more than the last 55 C-

terminal amino acid residues (i.e., a deletion of amino acid residues Glu (154) - Ser (208)) of Figure 1 (SEQ ID NO:2). Alternatively, the deletion will include at least the last C-terminal amino acid residue but not more than the last 65 C-terminal amino acid residues of Figure 1 (SEQ ID NO:2). Alternatively, the deletion will include at least the last 10 C-terminal amino acid residues but not more than the last 55 C-terminal amino acid residues of Figure 1 (SEQ ID NO:2). Alternatively, the deletion will include at least the last 20 C-terminal amino acid residues but not more than the last 55 C-terminal amino acid residues of Figure 1 (SEQ ID NO:2). Alternatively, the deletion will include at least the last 30 C-terminal amino acid residues but not more than the last 55 C-terminal amino acid residues of Figure 1 (SEQ ID NO:2). Alternatively, the deletion will include at least the last 40 C-terminal amino acid residues but not more than the last 55 C-terminal amino acid residues of Figure 1 (SEQ ID NO:2). Alternatively, the deletion will include at least the last 50 C-terminal amino acid residues but not more than the last 55 C-terminal amino acid residues of Figure 1 (SEQ ID NO:2).

In addition to the ranges of C-terminal deletion mutants described above, the present invention is also directed to all combinations of the above described ranges, e.g., deletions of at least the last C-terminal amino acid residue but not more than the last 10 C-terminal amino acid residues of Figure 1 (SEQ ID NO:2); deletions of at least the last C-terminal amino acid residue but not more than the last 20 C-terminal amino acid residues of Figure 1 (SEQ ID NO:2); deletions of at least the last C-terminal amino acid residue but not more than the last 30 C-terminal amino acid residues of Figure 1 (SEQ ID NO:2); deletions of at least the last C-terminal amino acid residue but not more than the last 40 C-terminal amino acid residues of Figure 1 (SEQ ID NO:2); deletions of at least the last 10 C-terminal amino acid residues but not more than the last 20 C-terminal amino acid residues of Figure 1 (SEQ ID NO:2); deletions of at least the last 10 C-terminal amino acid residues but not more than the last 30 C-terminal amino acid residues of Figure 1 (SEQ ID NO:2); deletions of at least the last 10 C-terminal amino acid residues but not more than the last 40 C-terminal amino acid residues of Figure

1 (SEQ ID NO:2); deletions of at least the last 20 C-terminal amino acid residues but not more than the last 30 C-terminal amino acid residues of Figure 1 (SEQ ID NO:2); etc. etc. etc.

5 In yet another aspect, also included by the present invention are deletion mutants having amino acids deleted from both the N- terminal and C-terminal residues. Such mutants include all combinations of the N-terminal deletion mutants and C-terminal deletion mutants described above. Such mutants include those comprising the amino acid sequence shown in Figure 1 (SEQ ID NO:2) except for a deletion of at least the first 46 N-terminal amino acid residues but not
10 more than the first 137 N-terminal amino acid residues of Figure 1 (SEQ ID NO:2) and a deletion of at least the last C-terminal amino acid residue but not more than the last 55 C-terminal amino acid residues of Figure 1 (SEQ ID NO:2). Alternatively, a deletion can include at least the first 62, 68, 76, 92, 103, or 122 N-terminal amino acids but not more than the first 137 N-terminal amino acid
15 residues of Figure 1 (SEQ ID NO:2) and a deletion of at least the last 10, 20, 30, 40, or 50 C-terminal amino acid residues but not more than the last 55 C-terminal amino acid residues of Figure 1 (SEQ ID NO:2). Further included are all combinations of the above described ranges.

Substitution of amino acids

20 A further aspect of the present invention also includes the substitution of amino acids. Native mature KGF-2 contains 44 charged residues, 32 of which carry a positive charge. Depending on the location of such residues in the protein's three dimensional structure, substitution of one or more of these clustered residues with amino acids carrying a negative charge or a neutral charge
25 may alter the electrostatic interactions of adjacent residues and may be useful to achieve increased stability and reduced aggregation of the protein. Aggregation of proteins cannot only result in a loss of activity but be problematic when preparing pharmaceutical formulations, because they can be immunogenic

(Pinckard *et al.*, *Clin. Exp. Immunol.* 2:331-340 (1967), Robbins *et al.*, *Diabetes* 36: 838-845 (1987), Cleland *et al.*, *Crit. Rev. Therapeutic Drug Carrier Systems* 10: 307-377 (1993)). Any modification should give consideration to minimizing charge repulsion in the tertiary structure of the protein molecule. Thus, of special interest are substitutions of charged amino acid with another charge and with neutral or negatively charged amino acids. The latter results in proteins with a reduced positive charge to improve the characteristics of KGF-2. Such improvements include increased stability and reduced aggregation of the analog as compared to the native KGF-2 protein.

The replacement of amino acids can also change the selectivity of binding to cell surface receptors. Ostade *et al.*, *Nature* 361: 266-268 (1993), described certain TNF alpha mutations resulting in selective binding of TNF alpha to only one of the two known TNF receptors.

KGF-2 molecules may include one or more amino acid substitutions, deletions or additions, either from natural mutation or human manipulation. Examples of some preferred mutations are: Ala (49) Gln, Asn (51) Ala, Ser (54) Val, Ala (63) Pro, Gly (64) Glu, Val (67) Thr, Trp (79) Val, Arg (80) Lys, Lys (87) Arg, Tyr (88) Trp, Phe (89) Tyr, Lys (91) Arg, Ser (99) Lys, Lys (102) Gln, Lys 103(Glu), Glu (104) Met, Asn (105) Lys, Pro (107) Asn, Ser (109) Asn, Leu (111) Met, Thr (114) Arg, Glu(117) Ala, Val (120) Ile, Val (123) Ile, Ala (125) Gly, Ile (126) Val, Asn (127) Glu, Asn (127) Gln, Tyr (130) Phe, Met (134) Thr, Lys (136) Glu, Lys (137) Glu, Gly (142) Ala, Ser (143) Lys, Phe (146) Ser, Asn (148) Glu, Lys (151) Asn, Leu (152) Phe, Glu (154) Gly, Glu (154) Asp, Arg (155) Leu, Glu (157) Leu, Gly (160) His, Phe (167) Ala, Asn (168) Lys, Gln (170) Thr, Arg (174) Gly, Tyr (177) Phe, Gly (182) Gln, Ala (185) Val, Ala (185) Leu, Ala (185) Ile, Arg (187) Gln (190) Lys, Lys (195) Glu, Thr (197) Lys, Ser (198) Thr, Arg (194) Glu, Arg (194) Gln, Lys (191) Glu, Lys (191) Gln, Arg (188) Glu, Arg (188) Gln, Lys (183) Glu.

By the designation, for example, Ala (49) Gln is intended that the Ala at position 49 of Figure 1 (SEQ ID NO:2) is replaced by Gln.

Changes are preferably of minor nature, such as conservative amino acid substitutions that do not significantly affect the folding or activity of the protein. Examples of conservative amino acid substitutions known to those skilled in the art are set forth below:

5	Aromatic:	phenylalanine tryptophan tyrosine
	Hydrophobic:	leucine isoleucine valine
10	Polar:	glutamine asparagine
	Basic:	arginine lysine
15	Acidic:	histidine aspartic acid glutamic acid
	Small:	alanine serine
20		threonine methionine glycine

Of course, the number of amino acid substitutions a skilled artisan would make depends on many factors, including those described above. Generally speaking, the number of substitutions for any given KGF-2 polypeptide will not be more than 50, 40, 30, 20, 10, 5, or 3, depending on the objective. For example, a number of substitutions that can be made in the C-terminus of KGF-2 to improve stability are described above and in Example 22.

Amino acids in KGF-2 that are essential for function can be identified by methods well known in the art, such as site-directed mutagenesis or alanine-scanning mutagenesis (Cunningham and Wells, *Science* 244:1081-1085 (1989)). The latter procedure introduces single alanine mutations at every residue in the molecule. The resulting mutant molecules are then tested for biological activity such as receptor binding or *in vitro* and *in vivo* proliferative activity. (See, e.g., Examples 10 and 11). Sites that are critical for ligand-receptor binding can also be determined by structural analysis such as crystallization, nuclear

magnetic resonance or photoaffinity labeling. (See for example: Smith *et al.*, *J. Mol. Biol.*, 224: 899-904 (1992); and de Vos *et al.* *Science*, 255: 306-312 (1992).)

Another aspect of the present invention substitutions of serine for cysteine at amino acid positions 37 and 106 and 150. An uneven number of cysteins means
5 that at least one cysteine residue is available for intermolecular crosslinks or bonds that can cause the protein to adopt an undesirable tertiary structure. Novel KGF-2 proteins that have one or more cysteine replaced by serine or e.g. alanine are generally purified at a higher yield of soluble, correctly folded protein. Although not proven, it is believed that the cysteine residue at position 106 is
10 important for function. This cysteine residue is highly conserved among all other FGF family members.

A further aspect of the present invention are fusions of KGF2 with other proteins or fragments thereof such as fusions or hybrids with other FGF proteins, e.g. KGF (FGF-7), bFGF, aFGF, FGF-5, FGF-6, etc. Such a hybrid has been
15 reported for KGF (FGF-7). In the published PCT application no. 90/0877T a chimeric protein has been produced consisting of the first 40 amino acid residues of KGF and the C-terminal portion of aFGF. The chimera has been reported to target keratinocytes like KGF, but lacked susceptibility to heparin, a characteristic of aFGF but not KGF. Fusions with parts of the constant domain of
20 immunoglobulins (IgG) show often an increased half-life time *in vivo*. This has been shown, e.g., for chimeric proteins consisting of the first two domains of the human CD4-polypeptide with various domains of the constant regions of the heavy or light chains of mammalian immunoglobulins (European Patent application, Publication No. 394 827, Traunecker et al., *Nature* 331, 84-86
25 (1988). Fusion proteins that have a disulfide-linked dimeric structure can also be more efficient in binding monomeric molecules alone (Fountoulakis *et al.*, *J. of Biochemistry*, 270: 3958-3964, (1995)).

Antigenic/hydrophilic parts of KGF-2

As demonstrated in Figure 4A-4E, there are 4 major highly hydrophilic regions in the KGF-2 protein. Amino acid residues Gly41 - Asn 71, Lys91 - Ser 109, Asn135 - Tyr 164 and Asn 181 - Ala 199 [SEQ ID NOS:25-28]. There are
5 two additional shorter predicted antigenic areas, Gln 74 - Arg 78 of Figure 1 (SEQ ID NO:2) and Gln 170 - Gln 175 of Figure 1 (SEQ ID NO:2). Hydrophilic parts are known to be mainly at the outside (surface) of proteins and, therefore, available for antibodies recognizing these regions. Those regions are also likely to be involved in the binding of KGF-2 to its receptor(s). Synthetic peptides
10 derived from these areas can interfere with the binding of KGF-2 to its receptor(s) and, therefore, block the function of the protein. Synthetic peptides from hydrophilic parts of the protein may also be agonistic, i.e. mimic the function of KGF-2.

Thus, the present invention is further directed to isolated polypeptides
15 comprising a hydrophilic region of KGF-2 wherein said polypeptide is not more than 150 amino acids in length, preferably not more than 100, 75, or 50 amino acids in length, which comprise one or more of the above described KGF-2 hydrophilic regions.

Chemical modifications

20 The KGF wild type and analogs may be further modified to contain additional chemical moieties not normally part of the protein. Those derivatized moieties may improve the solubility, the biological half life or absorption of the protein. The moieties may also reduce or eliminate any desirable side effects of the proteins and the like. an overview for those moieties can be found in
25 REMINGTON'S PHARMACEUTICAL SCIENCES, 18th ed., Mack Publishing Co., Easton, PA (1990). Polyethylene glycol (PEG) is one such chemical moiety

which has been used for the preparation of therapeutic proteins. The attachment of PEG to proteins has been shown to protect against proteolysis, Sada *et al.*, *J. Fermentation Bioengineering* 71: 137-139 (1991). Various methods are available for the attachment of certain PEG moieties. For review, see: Abuchowski *et al.*,
5 in *Enzymes as Drugs*. (Holcerberg and Roberts, eds.) pp. 367- 383 (1981). Many published patents describe derivatives of PEG and processes how to prepare them, e.g., Ono *et al.* U.S. Patent No. 5,342,940; Nitecki *et al.* U.S. Patent No. 5,089,261; Delgado *et al.* U.S. Patent No. 5,349,052. Generally, PEG molecules are connected to the protein via a reactive group found on the protein. Amino
10 groups, e.g. on lysines or the amino terminus of the protein are convenient for this attachment among others.

The entire disclosure of each document cited in this section on "Polypeptides and Peptides" is hereby incorporated herein by reference.

Vectors and Host Cells

15 The present invention also relates to vectors which include the isolated DNA molecules of the present invention, host cells which are genetically engineered with the recombinant vectors, and the production of KGF-2 polypeptides or fragments thereof by recombinant techniques.

20 Fragments or portions of the polypeptides of the present invention may be employed for producing the corresponding full-length polypeptide by peptide synthesis; therefore, the fragments may be employed as intermediates for producing the full-length polypeptides. Fragments or portions of the polynucleotides of the present invention may be used to synthesize full-length polynucleotides of the present invention. The present invention also relates to
25 vectors which include polynucleotides of the present invention, host cells which are genetically engineered with vectors of the invention and the production of polypeptides of the invention by recombinant techniques.

Host cells are genetically engineered (transduced or transformed or

transfected) with the vectors of this invention which may be, for example, a cloning vector or an expression vector. The vector may be, for example, in the form of a plasmid, a viral particle, a phage, etc. The engineered host cells can be cultured in conventional nutrient media modified as appropriate for activating promoters, selecting transformants or amplifying the KGF-2 genes. The culture conditions, such as temperature, pH and the like, are those previously used with the host cell selected for expression, and will be apparent to the ordinarily skilled artisan.

The polynucleotides of the present invention may be employed for producing polypeptides by recombinant techniques. Thus, for example, the polynucleotide may be included in any one of a variety of expression vectors for expressing a polypeptide. Such vectors include chromosomal, nonchromosomal and synthetic DNA sequences, e.g., derivatives of SV40; bacterial plasmids; phage DNA; baculovirus; yeast plasmids; vectors derived from combinations of plasmids and phage DNA, viral DNA such as vaccinia, adenovirus, fowl pox virus, and pseudorabies. However, any other vector may be used as long as it is replicable and viable in the host.

The appropriate DNA sequence may be inserted into the vector by a variety of procedures. In general, the DNA sequence is inserted into an appropriate restriction endonuclease site(s) by procedures known in the art. Such procedures and others are deemed to be within the scope of those skilled in the art.

The DNA sequence in the expression vector is operatively linked to an appropriate expression control sequences) (promoter) to direct cDNA synthesis. As representative examples of such promoters, there may be mentioned: LTR or SV40 promoter, the *E. coli* *lac* or *trp*, the phage lambda P_L promoter and other promoters known to control expression of genes in prokaryotic or eukaryotic cells or their viruses. The expression vector also contains a ribosome binding site for translation initiation and a transcription terminator. The vector may also include appropriate sequences for amplifying expression.

In addition, the expression vectors preferably contain one or more selectable marker genes to provide a phenotypic trait for selection of transformed host cells such as dihydrofolate reductase or neomycin resistance for eukaryotic cell culture, or such as tetracycline or ampicillin resistance in *E. coli*.

5 The vector containing the appropriate DNA sequence as hereinabove described, as well as an appropriate promoter or control sequence, may be employed to transform an appropriate host to permit the host to express the protein.

As representative examples of appropriate hosts, there may be mentioned:
10 bacterial cells, such as *E. coli*, *Streptomyces*, *Salmonella typhimurium*; fungal cells, such as yeast; insect cells such as *Drosophila S2* and *Spodoptera Sf9*; animal cells such as CHO, COS or Bowes melanoma; adenoviruses; plant cells, etc. The selection of an appropriate host is deemed to be within the scope of those skilled in the art from the teachings herein.

15 More particularly, the present invention also includes recombinant constructs comprising one or more of the sequences as broadly described above. The constructs comprise a vector, such as a plasmid or viral vector, into which a sequence of the invention has been inserted, in a forward or reverse orientation. In a preferred aspect of this embodiment, the construct further comprises
20 regulatory sequences, including, for example, a promoter, operably linked to the sequence. Large numbers of suitable vectors and promoters are known to those of skill in the art, and are commercially available. The following vectors are provided by way of example; Bacterial: pQE70, pQE60, pQE-9 (Qiagen), pBS, pDIO, phagescript, psiXI74, pbluescript SK, pbsks, pNH8A, pNH16a, pNH18A, pNH46A (Stratagene); ptrc99a, pKK223-3, pKK233-3, pDR540, pRIT5
25 (Pharmacia); Eukaryotic: pWLNEO, pSV2CAT, pOG44, pXT1, pSG (Stratagene) pSVK3, pBPV, pMSG, pSVL (Pharmacia). However, any other plasmid or vector may be used as long as they are replicable and viable in the host.

30 The present invention further includes novel expression vectors comprising operator and promoter elements operatively linked to nucleotide

sequences encoding a protein of interest. One example of such a vector is pHE4-5 which is described in detail below.

As shown in FIGs. 8 and 9, components of the pHE4-5 vector (SEQ ID NO:147) include: 1) a neomycinphosphotransferase gene as a selection marker, 2) an *E. coli* origin of replication, 3) a T5 phage promoter sequence, 4) two *lac* operator sequences, 5) a Shine-Delgarno sequence, 6) the lactose operon repressor gene (*lacIq*). The origin of replication (*oriC*) is derived from pUC19 (LTI, Gaithersburg, MD). The promoter sequence and operator sequences were made synthetically. Synthetic production of nucleic acid sequences is well known in the art. CLONTECH 95/96 Catalog, pages 215-216, CLONTECH, 1020 East Meadow Circle, Palo Alto, CA 94303. A nucleotide sequence encoding a KGF-2 polypeptide is operatively linked to the promoter and operator by inserting the nucleotide sequence between the *NdeI* and *Asp718* sites of the pHE4-5 vector.

As noted above, the pHE4-5 vector contains a *lacIq* gene. *LacIq* is an allele of the *lacI* gene which confers tight regulation of the *lac* operator. Amann, E. *et al.*, *Gene* 69:301-315 (1988); Stark, M., *Gene* 51:255-267 (1987). The *lacIq* gene encodes a repressor protein which binds to *lac* operator sequences and blocks transcription of down-stream (*i.e.*, 3') sequences. However, the *lacIq* gene product dissociates from the *lac* operator in the presence of either lactose or certain lactose analogs, *e.g.*, isopropyl B-D-thiogalactopyranoside (IPTG). KGF-2 thus is not produced in appreciable quantities in uninduced host cells containing the pHE4-5 vector. Induction of these host cells by the addition of an agent such as IPTG, however, results in the expression of the KGF-2 coding sequence.

The promoter/operator sequences of the pHE4-5 vector (SEQ ID NO:148) comprise a T5 phage promoter and two *lac* operator sequences. One operator is located 5' to the transcriptional start site and the other is located 3' to the same site. These operators, when present in combination with the *lacIq* gene product, confer tight repression of down-stream sequences in the absence of a *lac* operon inducer, *e.g.*, IPTG. Expression of operatively linked sequences located down-stream from the *lac* operators may be induced by the addition of a *lac*

operon inducer, such as IPTG. Binding of a *lac* inducer to the *lacIq* proteins results in their release from the *lac* operator sequences and the initiation of transcription of operatively linked sequences. *Lac* operon regulation of gene expression is reviewed in Devlin, T., TEXTBOOK OF BIOCHEMISTRY WITH
5 CLINICAL CORRELATIONS, 4th Edition (1997), pages 802-807.

The pHE4 series of vectors contain all of the components of the pHE4-5 vector except for the KGF-2 coding sequence. Features of the pHE4 vectors include optimized synthetic T5 phage promoter, *lac* operator, and Shine-Delagarno sequences. Further, these sequences are also optimally spaced so that
10 expression of an inserted gene may be tightly regulated and high level of expression occurs upon induction.

Among known bacterial promoters suitable for use in the production of proteins of the present invention include the *E. coli lacI* and *lacZ* promoters, the T3 and T7 promoters, the *gpt* promoter, the lambda PR and PL promoters and the
15 *trp* promoter. Suitable eukaryotic promoters include the CMV immediate early promoter, the HSV thymidine kinase promoter, the early and late SV40 promoters, the promoters of retroviral LTRs, such as those of the Rous Sarcoma Virus (RSV), and metallothionein promoters, such as the mouse metallothionein-I promoter.

The pHE4-5 vector also contains a Shine-Delgarno sequence 5' to the
20 AUG initiation codon. Shine-Delgarno sequences are short sequences generally located about 10 nucleotides up-stream (*i.e.*, 5') from the AUG initiation codon. These sequences essentially direct prokaryotic ribosomes to the AUG initiation codon.

Thus, the present invention is also directed to expression vector useful for
25 the production of the proteins of the present invention. This aspect of the invention is exemplified by the pHE4-5 vector (SEQ ID NO:147).

A cDNA encoding KGF-2 $\Delta 33$ inserted into the pHE4-5 expression vector was deposited at the ATCC on January 9, 1998 as ATCC No. 209575.

30 Promoter regions can be selected from any desired gene using CAT

(chloramphenicol transferase) vectors or other vectors with selectable markers. Two appropriate vectors are pKK232-8 and pCM7. Particular named bacterial promoters include lacI, lacZ, T3, T7, gpt, lambda P_R, P_L and trp. Eukaryotic promoters include CMV immediate early, HSV thymidine kinase, early and late SV40, LTRs from retrovirus, and mouse metallothionein-I. Selection of the appropriate vector and promoter is well within the level of ordinary skill in the art.

In a further embodiment, the present invention relates to host cells containing the above-described constructs. The host cell can be a higher eukaryotic cell, such as a mammalian cell, or a lower eukaryotic cell, such as a yeast cell, or the host cell can be a prokaryotic cell, such as a bacterial cell. Introduction of the construct into the host cell can be effected by calcium phosphate transfection, DEAE-Dextran mediated transfection, or electroporation (Davis, L. *et al.*, *Basic Methods in Molecular Biology* (1986)).

The constructs in host cells can be used in a conventional manner to produce the gene product encoded by the recombinant sequence. Alternatively, the polypeptides of the invention can be synthetically produced by conventional peptide synthesizers.

Mature proteins can be expressed in mammalian cells, yeast, bacteria, or other cells under the control of appropriate promoters. Cell-free translation systems can also be employed to produce such proteins using RNAs derived from the DNA constructs of the present invention. Appropriate cloning and expression vectors for use with prokaryotic and eukaryotic hosts are described by Sambrook *et al.*, *Molecular Cloning: A Laboratory Manual*, Second Edition, Cold Spring Harbor, N.Y. (1989), the disclosure of which is hereby incorporated by reference.

Transcription of the DNA encoding the polypeptides of the present invention by higher eukaryotes is increased by inserting an enhancer sequence into the vector. Enhancers are cis-acting elements of DNA, usually about from 10 to 300 bp that act on a promoter to increase its transcription. Examples including the SV40 enhancer on the late side of the replication origin bp 100 to

270, a cytomegalovirus early promoter enhancer, the polyoma enhancer on the late side of the replication origin, and adenovirus enhancers.

For secretion of the translated protein into the lumen of the endoplasmic reticulum, into the periplasmic space or into the extracellular environment, appropriate secretion signals may be incorporated into the expressed polypeptide. The signals may be endogenous to the polypeptide or they may be heterologous signals.

The polypeptide may be expressed in a modified form, such as a fusion protein, and may include not only secretion signals, but also additional heterologous functional regions. For instance, a region of additional amino acids, particularly charged amino acids, may be added to the N-terminus of the polypeptide to improve stability and persistence in the host cell, during purification, or during subsequent handling and storage. Also, peptide moieties may be added to the polypeptide to facilitate purification. Such regions may be removed prior to final preparation of the polypeptide. The addition of peptide moieties to polypeptides to engender secretion or excretion, to improve stability and to facilitate purification, among others, are familiar and routine techniques in the art. A preferred fusion protein comprises a heterologous region from immunoglobulin that is useful to solubilize receptors. For example, EP-A-O 464 533 (Canadian counterpart 2045869) discloses fusion proteins comprising various portions of constant region of immunoglobulin molecules together with another human protein or part thereof. In many cases, the Fc part in fusion protein is thoroughly advantageous for use in therapy and diagnosis and thus results, for example, in improved pharmacokinetic properties (EP-A 0232 262). On the other hand, for some uses it would be desirable to be able to delete the Fc part after the fusion protein has been expressed, detected and purified in the advantageous manner described. This is the case when Fc portion proves to be a hindrance to use in therapy and diagnosis, for example when the fusion protein is to be used as antigen for immunizations. In drug discovery, for example, human proteins, such as, shIL5-receptor has been fused with Fc portions for the purpose of high-

throughput screening assays to identify antagonists of hIL-5. See, D. Bennett et al., *Journal of Molecular Recognition*, Vol. 8 52-58 (1995) and K. Johanson et al., *The Journal of Biological Chemistry*, Vol. 270, No. 16, pp 9459-9471 (1995).

5 Generally, recombinant expression vectors will include origins of replication and selectable markers permitting transformation of the host cell, e.g., the ampicillin resistance gene of *E. coli* and *S. cerevisiae* TRP1 gene, and a promoter derived from a highly-expressed gene to direct transcription of a downstream structural sequence. Such promoters can be derived from operons encoding glycolytic enzymes such as 3-phosphoglycerate kinase (PGK), α -factor,
10 acid phosphatase, or heat shock proteins, among others. The heterologous structural sequence is assembled in appropriate phase with translation initiation and termination sequences, and preferably, a leader sequence capable of directing secretion of translated protein into the periplasmic space or extracellular medium. Optionally, the heterologous sequence can encode a fusion protein including an
15 N-terminal identification peptide imparting desired characteristics, e.g., stabilization or simplified purification of expressed recombinant product.

Useful expression vectors for bacterial use are constructed by inserting a structural DNA sequence encoding a desired protein together with suitable translation initiation and termination signals in operable reading phase with a
20 functional promoter. The vector will comprise one or more phenotypic selectable markers and an origin of replication to ensure maintenance of the vector and to, if desirable, provide amplification within the host. Suitable prokaryotic hosts for transformation include *E. coli*, *Bacillus subtilis*, *Salmonella typhimurium* and various species within the genera *Pseudomonas*, *Streptomyces*, and
25 *Staphylococcus*, although others may also be employed as a matter of choice.

As a representative but nonlimiting example, useful expression vectors for bacterial use can comprise a selectable marker and bacterial origin of replication derived from commercially available plasmids comprising genetic elements of the well known cloning vector pBR322 (ATCC 37017). Such commercial vectors
30 include, for example, pKK223-3 (Pharmacia Fine Chemicals, Uppsala, Sweden)

and GEM1 (Promega Biotec, Madison, WI, USA) These pBR322 "backbone" sections are combined with an appropriate promoter and the structural sequence to be expressed.

5 Following transformation of a suitable host strain and growth of the host strain to an appropriate cell density, the selected promoter is induced by appropriate means (e.g., temperature shift or chemical induction) and cells are cultured for an additional period.

Cells are typically harvested by centrifugation, disrupted by physical or chemical means, and the resulting crude extract retained for further purification.

10 Microbial cells employed in expression of proteins can be disrupted by any convenient method, including freeze-thaw cycling, sonication, mechanical disruption, or use of cell lysing agents, such methods are well known to those skilled in the art.

15 Various mammalian cell culture systems can also be employed to express recombinant protein. Examples of mammalian expression systems include the COS-7 lines of monkey kidney fibroblasts, described by Gluzman, *Cell* 23:175 (1981), and other cell lines capable of expressing a compatible vector, for example, the C127, 3T3, CHO, HeLa and BHK cell lines. Mammalian expression vectors will comprise an origin of replication, a suitable promoter and enhancer, and also any necessary ribosome binding sites, polyadenylation site, splice donor and acceptor sites, transcriptional termination sequences, and 5' flanking nontranscribed sequences. DNA sequences derived from the SV40 splice, and polyadenylation sites may be used to provide the required nontranscribed genetic elements.

25 The KGF-2 polypeptide can be recovered and purified from recombinant cell cultures by methods including ammonium sulfate or ethanol precipitation, acid extraction, anion or cation exchange chromatography, phosphocellulose chromatography, hydrophobic interaction chromatography, affinity chromatography, hydroxylapatite chromatography and lectin chromatography. Protein refolding steps can be used, as necessary, in completing configuration of

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the mature protein. Finally, high performance liquid chromatography (HPLC) can be employed for final purification steps.

5 The polypeptides of the present invention may be a naturally purified product, or a product of chemical synthetic procedures, or produced by recombinant techniques from a prokaryotic or eukaryotic host (for example, by bacterial, yeast, higher plant, insect and mammalian cells in culture). Depending upon the host employed in a recombinant production procedure, the polypeptides of the present invention may be glycosylated or may be non-glycosylated. Polypeptides of the invention may also include an initial methionine amino acid
10 residue.

Therapeutic Applications of KGF-2

As used in the section below, "KGF-2" is intended to refer to the full-length and mature forms of KGF-2 described herein and to the KGF-2 analogs, derivatives and mutants described herein.

Increase levels of Platelets

15 In one aspect, the invention is directed to increasing platelet level or number in blood for the purpose of alleviating thrombocytopenia. Determining the true cause of thrombocytopenia is a difficult and challenging clinical problem. Thrombocytopenia results from various causes, but ultimately occurs when
20 platelets are destroyed, sequestered in the body, or not produced. The differential diagnosis of thrombocytopenia is extensive and complex, and there is a significant overlap among disorders (Doyle B. and Porter D.L., A.A.C.N. Clin. Issues 1997 Aug; 8(3): 469-480). Thrombocytopenia may be caused by a variety of mechanisms including, but not limited to, drug induced hypersensitivity,
25 idiopathic thrombocytopenia purpura (ITP), posttransfusion purpura, neonatal thrombocytopenia, bone marrow deficiencies identified with metastatic tumors to the bone, aplastic anemia, myelofibrosis, acute and monocytic leukemia,

microangiopathic hemolytic anemia which includes disseminated intravascular coagulation (DIC), thrombotic thrombocytopenic purpura (TTP), hemolytic-uremic syndrome, prosthetic valve hemolytic syndrome, cancer chemotherapy, Zieve's syndrome, sepsis, HELLP preeclamptic syndrome, megaloblastic anemia
5 due to B12 and folic acid deficiency, infections such as peritonitis (without septicemia), congenital rubella syndrome, HIV-1 virus infections, Epstein-Barr infectious mononucleosis, rheumatoid-collagen diseases such as systemic lupus, hypertension of pregnancy associated with preeclampsia, thyrotoxicosis and uremia (*Clinical guide to laboratory tests*. (3rd ed). Philadelphia, W.B. Saunders
10 Company, 1995; *Clinical Laboratory Medicine. Clinical application of laboratory data*. (6th ed.) St. Louis, Mosby, 1995).

Accordingly, the present invention provides a process for administering KGF-2 polypeptides to an individual for alleviating thrombocytopenia. Suitable doses, formulations, and administration routes are described below.

15 ***Increase levels of Fibrinogen, Albumin and Serum Proteins***

Fibrinogen is a glycoprotein that is synthesized in the liver. Fibrinogen can give rise to fibrin split products (FDPs) in the following manner. Normally, thrombin catalyzes conversion of fibrinogen to fibrin by splitting two
20 fibrinopeptide molecules, known as fibrinopeptide A and B, from the central portion of fibrinogen. This action exposes polymerization sites on the remaining portion of the fibrinogen molecule, which is now called fibrin monomer. Fibrin monomers spontaneously aggregate together in side-to-side and end-to-end configurations to form a fibrin gel. Thrombin also activates factor XIII, which helps introduce cross-linking isopeptide bonds between the fibrin monomers to
25 form stabilized insoluble fibrin polymer. Fibrin polymer forms the scaffolding for blood clots. Fibrinolysins are naturally occurring or acquired enzymes that may attack either fibrinogen or fibrin or both, splitting off FDPs, which, in turn, are broken into smaller pieces. These split products may form a complex with fibrin monomers and interfere with polymerization. Fibrinogen degradation

products can be produced by action of primary fibrinolysin on fibrinogen and also by action of plasmin on fibrinogen and fibrin monomers or fibrin clots formed in a variety of conditions, normal and abnormal. Plasmin attacks intravascular blood clots formed as part of normal hemostasis (e.g., trauma or surgery) as well as blood clots that produce disease (e.g., thrombosis or embolization).

Decreased plasma fibrinogen levels may occur from decreased liver production resulting from acute hepatitis or cirrhosis, from the action of fibrinolysins which are enzymes that destroy fibrin and may also attack fibrinogen, and from conversion of fibrinogen to fibrin that is too extensive to permit adequate replacement of the fibrinogen. Decreased levels of plasma fibrinogen may be found in conditions of abnormal hepatic synthesis such as that associated with acute hepatitis or cirrhosis. The major etiology of hypofibrinogenemia other than severe liver disease is fibrinogen depletion caused by disseminated intravascular coagulation (DIC)(*Clinical guide to laboratory tests*. (3rd ed). Philadelphia, W.B. Saunders Company, 1995; *Clinical Laboratory Medicine. Clinical application of laboratory data*. (6th ed.) St. Louis, Mosby, 1995).

Accordingly, in a further aspect, there is provided a process for utilizing KGF-2 polypeptides to enhance or increase the fibrinogen level or number in plasma. Preferably, a KGF-2 polypeptide is administered to an individual for the purpose of alleviating hypofibrinogenemia. Suitable doses, formulations, and administration routes are described below.

Albumin is a serum protein produced by the liver which is most active in maintaining the serum oncotic pressure. Serum albumin also acts as a transport protein for some drugs and a few other substances. Hypoalbuminemia can be caused by a variety of mechanisms including, but not limited to, hemorrhages, burns, exudates, rheumatic diseases, granulomatous processes, most bacterial infections, viral infections accompanied by tissue destruction, tissue necrosis, vasculitis, ulcerative bowel disease, serositis, subacute bacterial endocarditis, parasitic infestations, acute and chronic liver disease, amyloidosis, malnutrition,

5 malignancy, congestive heart failure, constrictive pericarditis, cardiac valvular disease, nephrotic syndrome, trauma and crush injuries, gastrointestinal and lymphatic fistulae, and protein-losing gastroenteropathies (*Clinical guide to laboratory tests*. (3rd ed). Philadelphia, W.B. Saunders Company, 1995; *Clinical Laboratory Medicine. Clinical application of laboratory data*. (6th ed.) St. Louis, Mosby, 1995).

10 Accordingly, in a further aspect, there is provided a process for utilizing KGF-2 polypeptides to enhance or increase the level or number of serum albumin. Preferably, a KGF-2 polypeptide is administered to an individual for the purpose of alleviating hypoalbuminemia. Suitable doses, formulations, and administration routes are described below.

15 Serum globulin refers to a heterologous group of proteins such as glycoproteins, lipoproteins, and immunoglobulins. The globulins form the main transport system for various substances as well as constituting the antibody system, the clotting proteins, complement, and certain special duty substances such as the "acute reaction" proteins. Hypoglobulinemia may result from a number of conditions or afflictions including, but not limited to, alpha-1 antitrypsin deficiencies, severe liver disease, estrogen therapy, megaloblastic anemia, hypogammaglobulinemia and agammaglobulinemia (*Clinical guide to*
20 *laboratory tests*. (3rd ed). Philadelphia, W.B. Saunders Company, 1995; *Clinical Laboratory Medicine. Clinical application of laboratory data*. (6th ed.) St. Louis, Mosby, 1995).

25 Accordingly, in a further aspect, there is provided a process for utilizing KGF-2 polypeptides to enhance or increase the level or number of serum globulin. Preferably, a KGF-2 polypeptide is administered to an individual for the purpose of alleviating hypoglobulinemia. Suitable doses, formulations, and administration routes are described below.

30 KGF-2 can also be used to increase the levels of total serum protein in individuals with protein loss and/or decreased protein synthesis. Human serum contains many proteins including albumin, globulins, prothrombin, fibrinogen,

and other proteins synthesized exclusively by hepatocytes. Extensive liver injury may lead to decreased levels of these proteins (*Clinical guide to laboratory tests*. (3rd ed). Philadelphia, W.B. Saunders Company, 1995; *Clinical Laboratory Medicine. Clinical application of laboratory data*. (6th ed.) St. Louis, Mosby, 1995). Serum albumin levels are influenced by a variety of nonhepatic factors, most notably nutritional status, hormonal factors, and plasma oncotic pressure. Nephrotic syndrome or protein-losing enteropathy may lead to depressed serum albumin levels. Low serum albumin levels are also caused by familial idiopathic dysproteinemia, a rare genetic condition in which the albumin level is greatly decreased while all the globulin fractions are elevated (*Clinical guide to laboratory tests*. (3rd ed). Philadelphia, W.B. Saunders Company, 1995; *Clinical Laboratory Medicine. Clinical application of laboratory data*. (6th ed.) St. Louis, Mosby, 1995). Serum globulins include alpha and beta globulins as well as serum immunoglobulins. Alpha-1 globulins include alpha-1 antitrypsin, alpha-1 acid glycoprotein, alpha-1-fetoprotein, and certain carrier proteins such as cortisol-binding protein (transcortin) and thyroxine-binding globulin. Alpha-1 globulin is absent or nearly so in alpha-1 antitrypsin deficiency (*Clinical guide to laboratory tests*. (3rd ed). Philadelphia, W.B. Saunders Company, 1995; *Clinical Laboratory Medicine. Clinical application of laboratory data*. (6th ed.) St. Louis, Mosby, 1995). Alpha-2 globulins include haptoglobin, alpha-2 macroglobulin, and ceruloplasmin. Haptoglobin levels are decreased in severe liver disease, in patients on estrogen therapy, in megaloblastic anemia, and also in conditions in which free hemoglobin appears in the blood (RBC hemolysis) (*Clinical guide to laboratory tests*. (3rd ed). Philadelphia, W.B. Saunders Company, 1995; *Clinical Laboratory Medicine. Clinical application of laboratory data*. (6th ed.) St. Louis, Mosby, 1995). Ceruloplasmin levels are decreased in Wilson's disease, malnutrition, nephrotic syndrome, and protein losing enteropathy. Beta globulins include transferrin, beta-lipoprotein, and several components of complement. Transferrin is frequently decreased in protein malnutrition. Gamma globulins include immunoglobulins IgG, IgA, IgM,

IgD, and IgE. The gammaglobulins are decreased in hypogammaglobulinemia and agammaglobulinemia (*Clinical guide to laboratory tests*. (3rd ed). Philadelphia, W.B. Saunders Company, 1995; *Clinical Laboratory Medicine. Clinical application of laboratory data*. (6th ed.) St. Louis, Mosby, 1995).
5 Finally, serum contains a number of enzymes which have been used to distinguish and assess hepatocellular injury and biliary tract dysfunction or obstruction. For example, aspartate aminotransferase (AST) and alanine aminotransferase (ALT) catalyze the transfer of the γ -amino groups of aspartate and alanine, respectively, to the γ -keto groups of ketoglutarate, leading to the formation of oxaloacetic acid
10 and pyruvic acid. Uremia may lead to spuriously low aminotransferase levels (Harrison's Principles of Internal Medicine 11th edition Eugene Braunwald et. al., Editors (1987)).

Thus, total protein loss can be caused by a variety of mechanisms including, but not limited to, protein-losing gastroenteropathies, acute burns, and
15 nephrotic syndrome. Decreased protein synthesis can be caused by a variety of mechanisms including, but not limited to, chronic liver disease, malabsorption syndrome, malnutrition, and agammaglobulinemia. Accordingly, in a further aspect, there is provided a process for utilizing KGF-2 polypeptides to enhance or increase the level or number of total serum protein. Preferably, a KGF-2
20 polypeptide is administered to an individual for the purpose of alleviating diseases or conditions associated with protein loss. Suitable doses, formulations, and administration routes are described below.

Treatment of Cystitis

Hemorrhagic cystitis is a syndrome associated with certain disease states
25 as well as exposure to drugs, viruses, and toxins. It manifests as diffuse bleeding of the endothelial lining of the bladder. Known treatments include intravesical, systemic, and nonpharmacologic therapies (West, N.J., Pharmacotherapy 17:696-706 (1997)). Some cytotoxic agents used clinically have side effects resulting in the inhibition of the proliferation of the normal epithelial in the

bladder, leading to potentially life-threatening ulceration and breakdown in the epithelial lining. For example, cyclophosphamide is a cytotoxic agent which is biotransformed principally in the liver to active alkylating metabolites by a mixed function microsomal oxidase system. These metabolites interfere with the growth of susceptible rapidly proliferating malignant cells. The mechanism of action is believed to involve cross-linking of tumor cell DNA (Physicians' Desk reference, 1997).

Cyclophosphamide is one example of a cytotoxic agent which causes hemorrhagic cystitis in some patients, a complication which can be severe and in some cases fatal. Fibrosis of the urinary bladder may also develop with or without cystitis. This injury is thought to be caused by cyclophosphamide metabolites excreted in the urine. Hematuria caused by cyclophosphamide usually is present for several days, but may persist. In severe cases medical or surgical treatment is required. Instances of severe hemorrhagic cystitis result in discontinued cyclophosphamide therapy. In addition, urinary bladder malignancies generally occur within two years of cyclophosphamide treatment and occurs in patients who previously had hemorrhagic cystitis (CYTOXAN (cyclophosphamide) package insert). Cyclophosphamide has toxic effects on the prostate and male reproductive systems. Cyclophosphamide treatment can result in the development of sterility, and result in some degree of testicular atrophy.

As shown in Figures 23 and 24, systemic administration of KGF-2 to an individual stimulates proliferation of bladder and prostatic epithelial cells. Thus, in one aspect, the present invention provides a method of stimulating proliferation of bladder epithelium and prostatic epithelial cells by administering to an individual an effective amount of a KGF-2 polypeptide. More importantly, as Figures 25 and 26 demonstrate, KGF-2 can be used to reduce damage caused by cytotoxic agents having side effects resulting in the inhibition of bladder and prostate epithelial cell proliferation. To reduce such damage, KGF-2 can be administered either before, after, or during treatment with or exposure to the cytotoxic agent. Accordingly, in a further aspect, there is provided a method of

reducing damage caused by an inhibition of the normal proliferation of epithelial cells of the bladder or prostate by administering to an individual an effective amount of KGF-2. As indicated, inhibitors of normal proliferation of bladder or prostate epithelium include radiation therapy (causing acute or chronic radiation damage) and cytotoxic agents such as chemotherapeutic or antineoplastic drugs including, but not limited to, cyclophosphamide, busulfan, and ifosfamide. In a further aspect, KGF-2 is administered to reduce or prevent fibrosis and ulceration of the urinary bladder. Preferably, KGF-2 is administered to reduce or prevent hemorrhagic cystitis. Suitable doses, formulations, and administration routes are described below.

Stimulate the Proliferation of Nasal Mucosa

Sinus infections usually occur in the setting of upper respiratory tract infections, allergies, or anatomic defects (within the sinuses or nasal septum) and may lead to symptoms of headache, facial pain, fever, and purulent rhinorrhea. (Evans KL. *Drugs* 56(1): 59-71 (1998)). The symptoms of nasal allergy and chronic ethmoid sinusitis overlap and treatment failure in allergic patients may suggest possible chronic sinusitis. Chronic ethmoidal sinusitis may be the leading cause of rhinorrhea and nasal obstruction in patients with perennial allergies. (Bertrand *et al.*, *Acta Otorhinolaryngol Belg* 51(4):227-237 (1997)). Chronic sinusitis is identified when symptoms of nasal obstruction, rhinorrhea, post nasal drip, intermittent facial pain (Evans KL. *Drugs* 56(1): 59-71 (1998)) and anosmia (Jones *et al.*, *Int. J. Pediatr. Otorhinolaryngol.* 28(1):25-32 (1993)) persist for 3 months or more. In addition to poor mucociliary transport and obstructed ostia, chronic sinusitis is also associated with mucosal edema, mucous hypersecretion, and persistent or recurrent infection.

Acute sinusitis tends to occur in patients with a history of rhinitis, which may be allergic or non-allergic in origin. Patients with anatomic variants (Evans KL. *Drugs* 56(1): 59-71 (1998)) and cystic fibrosis (Brihaye *et al.*, *Acta Otorhinolaryngol Belg* 51(4):323-337 (1997); Ramsey *et al.*, *J. Allergy Clin.*

Immunol. 90(3Pt2):547-552 (1992); Davidson *et al.*, *Laryngoscope* 105(4Pt1):354-358 (1995); Jones *et al.*, *Int. J. Pediatr. Otorhinolaryngol.* 28(1):25-32 (1993)) are also at high risk for developing sinusitis. Acute inflammation and infection are associated with reduced mucociliary transport of secretions and obstruction of the ostia, which drain the sinuses. Initial medical treatment for acute sinusitis begins with analgesia to control pain; topical and systemic treatment of rhinitis, which may include antihistamines, mast cell stabilizers, and steroids; measures to clear secretions including steam inhalation and saline nasal douches; and when infection can be documented, antibiotics. (Evans KL. *Drugs* 56(1): 59-71 (1998)).

A general understanding of the pathophysiology of sinusitis is now available. In particular, it is known that occlusion of the sinus ostia starts the cycle of events, which lead to and sustain sinusitis. (Reilly J.S. *Otolaryngology Head and Neck Surgery* 103(5):856-862(1990)). The goals of treatment for both acute and chronic sinusitis are to control the rhinitis, improve ventilation to the sinuses, and to improve the function of the sinuses for clearance of secretions. (Evans KL. *Drugs* 56(1): 59-71 (1998)). Nasal sinus surgery is performed only after there is evidence of persistent chronic sinusitis uncontrolled by medical treatment.

Surgical treatment is only considered when medical measures fail to control the sinusitis. The goals of treatment are identical: to improve ventilation and to facilitate or restore sinus drainage. An additional goal is that surgical treatment may sometimes improve the penetration of topical drugs into the sinus. Up to 250,000 procedures are performed each year in the United States. The majority of the procedures performed use endoscopic methods (Stammberger H. *Otolaryngology Head and Neck Surgery* 94(2):143-147 (1986); Stammberger H. *Otolaryngology Head and Neck Surgery* 94(2):147-156 (1986)) with CT or x-ray tomographic assessment to identify specific lesions. The extent of surgery is kept to a minimum and is intended to remove only the primary anatomic cause that perpetuates the chronic sinusitis.

In the course of performing sinus surgery, the mucosal surface is stripped away or damaged. In cases where the surgery has been extensive, the underlying bone within the sinus may be exposed for periods of up to 6 months before the mucosa is fully reconstituted and recovery of ciliary density may require up to 2 years to achieve. Although not proven, delayed re-epithelialization of the nasal sinuses following surgery is believed to be associated with increased risk of infection, scarring (subepithelial fibrosis) leading to recurrent disease, and cyst formation. After 2 years of follow up approximately 2-5% of patients will have recurrent disease and up to 15% may require surgical revision. (Evans KL. *Drugs* 56(1): 59-71 (1998)) Other complications, which might be favorably impacted by accelerated re-epithelialization, include infectious complications (Evans KL. *Drugs* 56(1): 59-71 (1998)), failure to regain olfaction (Klossek *et al.*, *Otolaryngology Head and Neck Surgery* 117(4):355-361 (1997)), recurrence of polyps (Klossek *et al.*, *Otolaryngology Head and Neck Surgery* 117(4):355-361 (1997)) and requirement for additional post operative medical treatment (Smith *et al.*, *Otolaryngology Head and Neck Surgery* 108(6):688-696 (1993)). Minor complications have been reported to occur in up to 8% of cases and approximately 40% of patients continued to require medical treatment for nasal congestion and discomfort even following surgery. (Smith *et al.*, *Otolaryngology Head and Neck Surgery* 108(6):688-696 (1993)).

Following endoscopic nasal surgery patients return at weekly intervals for repeat endoscopy and debridement. At each visit local anesthesia is applied, and the sinus cavity is cleaned, including removal of adhesions (which occur in 10-15% of cases) and mucus crusts. The duration of post op care is proportional to the extent of the surgery and the loss of the sinus epithelium. For simple cases 6 to 8 weeks of care may be needed. For complex or more extensive cases, 12 to 18 weeks may be required. Accelerated healing of the sinus epithelium would reduce the duration of postoperative discomfort to the patient and reduce the cost of care.

Administration of KGF-2 to an individual stimulates proliferation of the

sinus epithelia and nasal mucosa. KGF-2 administration also results in goblet cell hyperplasia in the respiratory epithelium of the nasal air passage way. Thus, in one aspect, the present invention provides a method of stimulating the healing of mucosa of the sinus following damage by surgery or other pathological conditions by administration of KGF-2. Further, the present invention, KGF-2 is administered to stimulate the healing wounds located in the nasal and sinus mucosa. The present invention also provides for KGF-2 administration to improve function of the sinuses by increasing and/or protecting ciliary density and mucosal integrity. Another aspect of the invention is to provide a method decreasing sinus infection, scarring, polyps, cyst formation and recurrence as well as increasing olfaction by KGF-2 administration. Suitable doses, formulations, and administration routes are described below.

Increase Proliferation of Salivary and Lacrimal Glands

Saliva is secreted from three major salivary glands: the parotid, sublingual and submandibular (or submaxillary) salivary glands. Tears are secreted from lacrimal glands. Loss of the ability to produce adequate amounts of saliva and tears is a major clinical problem affecting millions of people and there are few therapeutic options for these sufferers. Patients with xerostomia, or dry mouth, do not produce adequate amounts of saliva, have difficulty swallowing, have painful cracks in their mouths, and experience a decrease in their ability to taste. This condition may be caused by Sjogren's syndrome, as a secondary event to radiation used with patients with head and neck tumors, and to drugs. Patients with Sjogren's syndrome sometimes have keratoconjunctivitis sicca or dry eye. This condition may be caused by damage to the lacrimal gland due to Sjogren's syndrome, sarcoidosis, aging, HIV infection, burns, etc. (Lemp, M.A., *Adv. Exp. Med. Biol.* 438:791-803 (1998)). Patients experience irritation, blurring of vision, burning, pain, and increased risk of infections. Millions of patients suffer with Sjogren's syndrome and therapy is sub-optimal. Stress is placed on reducing the risk of dental caries and the use of moistening agents. If there is remaining

5 salivary tissue patients are treated with pilocarpine, which induces saliva production (Guchelaar, H.J. and Meerwaldt, V.A., *Support Care Cancer* 5:281-288 (1997); Garg, A.C. and Malo, M., *J. Am. Dent. Assoc.* 128:1128-1133 (1997); Wiseman, L.R. and Faulds, D., *Drugs* 49:143-155 (1995); and LeVeque, F.G., *et al.*, *J. Clin. Oncol.* 11:1124-1131 (1993)). A recent study has shown that treatment with IFN- α can reduce lymphocytic infiltration in the salivary glands of patients with Sjogren's syndrome and improve function (Shiozawa, S., *et al.*, *J. Interferon Cytokine Res.* 18:255-262 (1998)). However, such therapy, if approved, would impact only those patients whose salivary gland dysfunction is due to this autoimmune disease.

10 As is the case with xerostomia, patients with keratoconjunctivitis sicca have few therapeutic options. At this time there are approximately 10 million patients in the US which require artificial tear preparations (Lemp, M.A., *Adv. Exp. Med. Biol.* 438:791-803 (1998)). There are no treatments available at this time to stimulate replacement of the cells in the salivary and lacrimal gland cells.

15 Two classifications of patients with "dry eye" are commonly used (Pflugfelder, S.C., *Adv. Dent. Res.* 10(1): 9-12 (1996)). One class being aqueous adequate dry eye. This clinical disorder is associated with meibomian gland dysfunction resulting in a deficiency in the superficial lipid layer of the tear film. Drop out of meibomian glands can be visualized by transillumination biomicroscopy of the eyelids. The second class being aqueous deficient dry eye. This clinical disorder may be immunologic (Sjogren's syndrome) or non-immunologic (non-Sjogren's syndrome). Aqueous tear deficiencies lead to ocular surface disease, termed keratoconjunctivitis sicca, which results from either pathology in the lacrimal gland or in mucin-producing epithelial cells. Lower goblet cell densities have been reported in the conjunctival epithelium in patients with dry eye syndrome (Ralph, R.A., *Investigative Ophthalmology* 14(4): 299-302, (1975)).

25 Although dry eye syndromes have not been associated with deficiencies in specific growth factors, the lacrimal gland produces epidermal growth factor,

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which may play a role in ocular surface wound healing (Wilson, S.E., *American Journal of Ophthalmology* 111 (6): 763-765 (1991)). The presence of endogenous growth factors in lacrimal secretions provides the rationale for the use of topically applied keratinocyte growth factor to support the growth and differentiation of the conjunctival epithelium. In addition, atrophy or losses of secretory acini in the lacrimal gland contribute to defective tear production.

KGF-2 effects on the proliferative rate of cells in the salivary and lacrimal glands in normal rats were investigated in Example 24. Three major salivary glands exist in mammals: the parotid, sublingual and submandibular or submaxillary salivary glands. One intravenous administration of KGF-2 induced an almost forty-fold increase in the proliferation of serous cells in the parotid gland, an eighteen-fold elevation in the proliferation of serous and mucous cells in the submandibular gland, and a ten-fold increase in the proliferation of serous cells in the lacrimal gland. The enhanced proliferation in the salivary and lacrimal gland cells induced by KGF-2 was reversible.

KGF-2 produces a dramatic increase in the proliferation of normal serous and mucous secretory cells in salivary and lacrimal glands of normal rats but does not appear to elicit a proliferative response of ductal cells. (See, Example 24). This effect on the salivary and lacrimal glands reverses upon removal of treatment suggesting KGF-2 would prove safe and effective in promoting regeneration of the cells of these glands.

In addition to stimulating proliferation of the salivary glands, daily i.v. injections of KGF-2Δ33 resulted in grossly visible thickening of the oral and esophageal mucosa in cynomolgus monkeys. (See, Example 36). The grossly visible thickening of the oral and esophageal mucosa correlated with oral and esophageal mucosal hyperkeratosis.

Since KGF-2Δ33 has shown proliferative effects on secretory tissues such as salivary glands and the pancreas, the effect of systemic administration of KGF-2Δ33 on the lacrimal glands was also investigated in Example 25. The results demonstrates that the lacrimal gland proliferates after 1, 2, and 3 daily i.v.

5 treatments with KGF-2Δ33. However, the gland fails to demonstrate elevated proliferation after 7 daily administrations of this growth factor, a situation that has been observed in many organs and tissues. (See, Example 25). These results indicate that topical or systemic administration of KGF-2Δ33 would be expected stimulate a therapeutic increase in the secretory capacity of the glands by its proliferative effect on lacrimal epithelial cells.

10 Accordingly, the invention provides for a method of stimulating the growth of the parotid, sublingual and submandibular (or submaxillary) salivary gland cells by administration of KGF-2 to a patient in need thereof. The invention also provides a method of stimulating the growth of lacrimal gland cells by administration of KGF-2 to a patient in need thereof. In particular, KGF-2 can be administered to treat or prevent keratoconjunctivitis sicca, xerostomia or other pathologies and injuries to the lacrimal gland, salivary gland or mucosa caused by radiation therapy, autoimmune disease, sarcoidosis, aging, HIV
15 infection, burns, etc. Suitable doses, formulations, and administration routes are described below.

Stimulating Proliferation of Goblet Cells

As indicated above, administration of KGF-2 to an individual also stimulates proliferation of Goblet cells in the respiratory epithelium of the nasal
20 air passage way (Example 37). As demonstrated in Example 29, KGF-2 administration also results in proliferation of Goblet cells in the conjunctiva. The present inventors have further demonstrated that KGF-2 administration stimulates proliferation of Goblet cells in the large and small intestines. Thus, the present invention further provides a method for stimulating proliferation of Goblet cells
25 by administration of KGF-2 to an individual in need thereof. Stimulating Goblet cell proliferation can be used for a number of purposes, including treating or preventing dry eye and radiation induced damage (such as during cancer therapies). Suitable doses, formulations, and administration routes are described

below.

Lung Epithelial Cell Proliferation

KGF-2 stimulates proliferation of lung epithelial cells. Thus, KGF-2 can be administered prophylactically to reduce or prevent damage to the lungs caused by various pathological states. KGF-2 can also be administered during or after a damaging event occurs to promote healing. For example, KGF-2 can stimulate proliferation and differentiation and promote the repair of alveoli and bronchiolar epithelium to prevent, attenuate, or treat acute or chronic lung damage. Emphysema, which results in the progressive loss of alveoli, and inhalation injuries, *i.e.*, resulting from smoke inhalation and burns, that cause necrosis of the bronchiolar epithelium and alveoli could be effectively treated using KGF-2 as could damage attributable to chemotherapy, radiation treatment, lung cancer, asthma, black lung and other lung damaging conditions. Also, KGF-2 could be used to stimulate the proliferation of and differentiation of type II pneumocytes, which may help treat or prevent disease such as hyaline membrane diseases, such as infant respiratory distress syndrome and bronchopulmonary dysplasia, in premature infants.

KGF-2 stimulates proliferation of lung epithelial cells by direct intratracheal administration. Further, administration of nebulized KGF-2 also stimulates cell proliferation as does KGF-2 administered intravenously. Moreover, as demonstrated in Example 32, KGF-2 is useful prophylactically for lung fibrosis.

As used herein, by "individual" is intended an animal, preferably a mammal (such as apes, cows, horses, pigs, boars, sheep, rodents, goats, dogs, cats, chickens, monkeys, rabbits, ferrets, whales, and dolphins), and more preferably a human.

Pharmaceutical Compositions

5 The KGF-2 polypeptides of the present invention may be employed in combination with a suitable pharmaceutical carrier to comprise a pharmaceutical composition. Such compositions comprise a therapeutically effective amount of the polypeptide, agonist or antagonist and a pharmaceutically acceptable carrier or excipient. Such a carrier includes but is not limited to saline, buffered saline, dextrose, water, glycerol, ethanol, and combinations thereof. The formulation should suit the mode of administration.

10 The invention also provides a pharmaceutical pack or kit comprising one or more containers filled with one or more of the ingredients of the pharmaceutical compositions of the invention. Associated with such containers can be a notice in the form prescribed by a governmental agency regulating the manufacture, use or sale of pharmaceuticals or biological products, which notice reflects approval by the agency of manufacture, use or sale for human
15 administration. In addition, the polypeptides, agonists and antagonists of the present invention may be employed in conjunction with other therapeutic compounds.

The polypeptide having KGF-2 activity may be administered in pharmaceutical compositions in combination with one or more pharmaceutically
20 acceptable excipients. It will be understood that, when administered to a human patient, the total daily usage of the pharmaceutical compositions of the present invention will be decided by the attending physician within the scope of sound medical judgment. The specific therapeutically effective dose level for any particular patient will depend upon a variety of factors including the type and
25 degree of the response to be achieved; the specific composition and other agent, if any, employed; the age, body weight, general health, sex and diet of the patient; the time of administration, route of administration, and rate of excretion of the composition; the duration of the treatment; drugs (such as a chemotherapeutic agent) used in combination or coincidental with the specific composition; and like

factors well known in the medical arts. Suitable formulations, known in the art, can be found in *Remington's Pharmaceutical Sciences* (latest edition), Mack Publishing Company, Easton, PA.

5 The KGF-2 composition to be used in the therapy will be formulated and dosed in a fashion consistent with good medical practice, taking into account the clinical condition of the individual patient (especially the side effects of treatment with KGF-2 alone), the site of delivery of the KGF-2 composition, the method of administration, the scheduling of administration, and other factors known to practitioners. The "effective amount" of KGF-2 for purposes herein is thus
10 determined by such considerations.

The pharmaceutical compositions may be administered in a convenient manner such as by the oral, topical, intravenous, intraperitoneal, intramuscular, intraarticular, subcutaneous, intranasal, intratracheal, intraocular, inhalation, or intradermal routes. The pharmaceutical compositions are administered in an
15 amount which is effective for treating and/or prophylaxis of the specific indication. In most cases, the KGF-2 dosage is from about 1 $\mu\text{g/kg}$ to about 30 mg/kg body weight daily, taking into account the routes of administration, symptoms, etc. However, the dosage can be as low as 0.001 $\mu\text{g/kg}$. For example, in the specific case of topical administration dosages are preferably administered
20 from about 0.01 μg to 9 mg per cm^2 . In the case of intranasal and intraocular administration, dosages are preferably administered from about 0.001 $\mu\text{g/ml}$ to about 10 mg/ml , and more preferably from about 0.05 mg/ml to about 4 mg/ml .

As a general proposition, the total pharmaceutically effective amount of the KGF-2 administered parenterally per more preferably dose will be in the range
25 of about 1 $\mu\text{g/kg/day}$ to 100 mg/kg/day of patient body weight, although, as noted above, this will be subject to therapeutic discretion. If given continuously, the KGF-2 is typically administered at a dose rate of about 1 $\mu\text{g/kg/hour}$ to about 50 $\mu\text{g/kg/hour}$, either by 1-4 injections per day or by continuous subcutaneous infusions, for example, using a mini-pump. An intravenous bag solution or bottle
30 solution may also be employed.

More preferably, KGF-2 is administered intravenously at dose range of

about 0.5 mg/kg to about 30 mg/kg to treat cystitis, hypoalbuminemia, hypofibrinogenemia, hypogammaglobulinemia, hemorrhagic cystitis, stimulating salivary gland epithelia, lung damage or injuries, stimulating sinus and nasal mucosa. KGF-2 is preferably nebulized and administered by inhalation at a dose
5 range of about 6 mg to about 20 mg to treat pulmonary diseases and conditions as well as for nasal and sinus epithelium stimulation.

A course of KGF-2 treatment to affect the fibrinolytic system appears to be optimal if continued longer than a certain minimum number of days, 7 days in the case of the mice. The length of treatment needed to observe changes and the
10 interval following treatment for responses to occur appears to vary depending on the desired effect. Such treatment lengths are indicated in the Examples below. The KGF-2 polypeptide is also suitably administered by sustained-release systems. Suitable examples of sustained-release compositions include semi-permeable polymer matrices in the form of shaped articles, e.g., films, or
15 microcapsules. Sustained-release matrices include polylactides (U.S. Pat. No. 3,773,919, EP 58,481), copolymers of L-glutamic acid and gamma-ethyl-L-glutamate (U. Sidman *et al.*, *Biopolymers* 22:547-556 (1983)), poly (2-hydroxyethyl methacrylate) (R. Langer *et al.*, *J. Biomed. Mater. Res.* 15:167-277 (1981), and R. Langer, *Chem. Tech.* 12:98-105 (1982)), ethylene vinyl acetate (R.
20 Langer *et al.*, *Id.*) or poly-D-(-)-3-hydroxybutyric acid (EP 133,988). Sustained-release KGF-2 compositions also include liposomally entrapped KGF-2. Liposomes containing KGF-2 are prepared by methods known *per se*: DE 3,218,121; Epstein, *et al.*, *Proc. Natl. Acad. Sci. USA* 82:3688-3692 (1985); Hwang *et al.*, *Proc. Natl. Acad. Sci. USA* 77:4030-4034 (1980); EP 52,322; EP
25 36,676; EP 88,046; EP 143,949; EP 142,641; Japanese Pat. Appl. 83-118008; U.S. Pat. Nos. 4,485,045 and 4,544,545; and EP 102,324. Ordinarily, the liposomes are of the small (about 200-800 Angstroms) unilamellar type in which the lipid content is greater than about 30 mol. percent cholesterol, the selected proportion being adjusted for the optimal KGF-2 therapy.

30 For parenteral administration, in one embodiment, the KGF-2 is formulated generally by mixing it at the desired degree of purity, in a unit dosage

injectable form (solution, suspension, or emulsion), with a pharmaceutically acceptable carrier, i.e., one that is non-toxic to recipients at the dosages and concentrations employed and is compatible with other ingredients of the formulation. For example, the formulation preferably does not include oxidizing agents and other compounds that are known to be deleterious to polypeptides.

KGF-2 may also be administered to the eye to treat lacrimal gland injuries, disorders and pathologies in animals and humans as a drop, or within ointments, gels, liposomes, or biocompatible polymer discs, pellets or carried within contact lenses. The intraocular composition may also contain a physiologically compatible ophthalmic vehicle as those skilled in the art can select using conventional criteria. The vehicles may be selected from the known ophthalmic vehicles which include but are not limited to water, polyethers such as polyethylene glycol 400, polyvinyls such as polyvinyl alcohol, povidone, cellulose derivatives such as carboxymethylcellulose, methylcellulose and hydroxypropyl methylcellulose, petroleum derivatives such as mineral oil and white petrolatum, animal fats such as lanolin, vegetable fats such as peanut oil, polymers of acrylic acid such as carboxyl polymethylene gel, polysaccharides such as dextrans and glycosaminoglycans such as sodium chloride and potassium, chloride, zinc chloride and buffer such as sodium bicarbonate or sodium lactate. High molecular weight molecules can also be used. Physiologically compatible preservatives which do not inactivate the KGF-2 present in the composition include alcohols such as chlorobutanol, benzalkonium chloride and EDTA, or any other appropriate preservative known to those skilled in the art.

KGF-2 can also be intranasally administered to the nasal mucosa to treat disorders, injuries and pathologies of the nasal mucosa and sinus epithelia in animals and humans as drops or in a spray form. Various types of nasal delivery devices are well known in the art. In general, peptides are administered in an aqueous solution are often administered by means of metered-dose spray pumps. For intranasal administration, suspensions will generally be aqueous solutions which contain a physiologically compatible vehicle as those skilled in the art can select using conventional criteria. For example, the suspension may be prepared

from water alone (e.g., sterile or pyrogen-free water), water and a physiologically acceptable non aqueous vehicle (e.g., ethanol, propylene glycol, polyethylene glycols such as PEG 400, etc.). Such suspensions may additionally contain other excipients, for example, preservatives (e.g., benzalkonium chloride, phenylethylalcohol, and other known quaternary amines, etc.), wetting agents/surfactants (e.g., polysorbates such as Tween 80; sorbitan esters such as Span 80), buffering agents (e.g., acetic acid/sodium acetate, citric acid/disodium hydrogen phosphate, sodium dihydrogen phosphate/disodium hydrogen phosphate, and citric acid/sodium citrate, etc.), osmotic pressure controlling agents (e.g., sodium chloride), mucosal absorption enhancers (e.g., bile salts, monolauryl esters of macrogols, phospholipids and fusidate derivatives), and viscosity enhancers (e.g., acacia, bentonite, carboxymethylcellulose, gelatin, hydroxymethylcellulose, methylcellulose and the like).

KGF-2 intranasal administration may also be achieved by means of an aerosol formulation in which the peptide composition is provided in a pressurized pack with a suitable propellant such as a chlorofluorocarbon (CFC), a hydrofluorocarbon (HFC), carbon dioxide or other suitable gas. The aerosol may also contain a surfactant such as lecithin. The dose of the drug may be controlled by a metered valve device well known to those in the art.

Generally, the formulations are prepared by contacting the KGF-2 uniformly and intimately with liquid carriers or finely divided solid carriers or both. Then, if necessary, the product is shaped into the desired formulation. Preferably the carrier is a parenteral carrier, more preferably a solution that is isotonic with the blood of the recipient. Examples of such carrier vehicles include water, saline, Ringer's solution, and dextrose solution. Non-aqueous vehicles such as fixed oils and ethyl oleate are also useful herein, as well as liposomes. Suitable formulations, known in the art, can be found in *Remington's Pharmaceutical Sciences* (latest edition), Mack Publishing Company, Easton, PA.

The carrier suitably contains minor amounts of additives such as substances that enhance isotonicity and chemical stability. Such materials are non-toxic to recipients at the dosages and concentrations employed, and include

5 buffers such as phosphate, citrate, succinate, acetic acid, and other organic acids or their salts; antioxidants such as ascorbic acid; low molecular weight (less than about ten residues) polypeptides, e.g., polyarginine or tripeptides; proteins, such as serum albumin, gelatin, or immunoglobulins; hydrophilic polymers such as polyvinylpyrrolidone; amino acids, such as glycine, glutamic acid, aspartic acid, or arginine; monosaccharides, disaccharides, and other carbohydrates including cellulose or its derivatives, glucose, mannose, or dextrans; chelating agents such as EDTA; sugar alcohols such as mannitol or sorbitol; counterions such as sodium; and/or nonionic surfactants such as polysorbates, poloxamers, or PEG.

10 KGF-2 is typically formulated in such vehicles at a concentration of about 0.01 $\mu\text{g/ml}$ to 100 mg/ml , preferably 0.01 $\mu\text{g/ml}$ to 10 mg/ml , at a pH of about 3 to 8. It will be understood that the use of certain of the foregoing excipients, carriers, or stabilizers will result in the formation of KGF-2 salts.

15 KGF-2 to be used for therapeutic administration must be sterile. Sterility is readily accomplished by filtration through sterile filtration membranes (e.g., 0.2 micron membranes). Therapeutic KGF-2 compositions generally are placed into a container having a sterile access port, for example, an intravenous solution bag or vial having a stopper pierceable by a hypodermic injection needle.

20 KGF-2 ordinarily will be stored in unit or multi-dose containers, for example, sealed ampules or vials, as an aqueous solution or as a lyophilized formulation for reconstitution. As an example of a lyophilized formulation, 10 ml vials are filled with 5 ml of sterile-filtered 1% (w/v) aqueous KGF-2 solution, and the resulting mixture is lyophilized. The infusion solution is prepared by reconstituting the lyophilized KGF-2 using bacteriostatic Water-for-Injection.

25 Dosaging may also be arranged in a patient specific manner to provide a predetermined concentration of an KGF-2 activity in the blood, as determined by an RIA technique, for instance. Thus patient dosaging may be adjusted to achieve regular on-going trough blood levels, as measured by RIA, on the order of from 50 to 1000 ng/ml , preferably 150 to 500 ng/ml .

30 Pharmaceutical compositions of the invention may be administered orally, rectally, parenterally, intracisternally, intradermally, intravaginally,

intraperitoneally, topically (as by powders, ointments, gels, creams, drops or transdermal patch), buccally, or as an oral or nasal spray. By "pharmaceutically acceptable carrier" is meant a non-toxic solid, semisolid or liquid filler, diluent, encapsulating material or formulation auxiliary of any type. The term
5 "parenteral" as used herein refers to modes of administration which include intravenous, intramuscular, intraperitoneal, intrasternal, subcutaneous and intraarticular injection and infusion.

Preferred KGF-2 formulations are described in U.S. Provisional Application No. 60/068,493, filed December 22, 1997, and the U.S. Non
10 Provisional Application, filed on December 22, 1998 (Attorney Docket No. 1488.1030001), both of which are herein incorporated by reference.

Gene Therapy

The KGF-2 polypeptide of the present invention may be employed by expression of the polypeptide *in vivo*, which is often referred to as "gene therapy".
15 The gene therapy method relates to the introduction of nucleic acid (DNA, RNA and antisense DNA or RNA) sequences encoding KGF-2 polypeptides into an animal to achieve expression of a KGF-2 polypeptide. Such gene therapy and delivery techniques are known in the art. See, for example, WO 90/11092, which is herein incorporated by reference.

20 As discussed more fully below, the KGF-2 polynucleotide sequences preferably have a therapeutic effect after being taken up by a cell. Examples of polynucleotides that are themselves therapeutic are anti-sense DNA and RNA; DNA coding for an anti-sense RNA; or DNA coding for tRNA or rRNA to replace defective or deficient endogenous molecules. For example, a promoter
25 may be operably linked to a DNA sequence encoding for an antisense RNA. The antisense RNA oligonucleotide hybridizes to the mRNA *in vivo* and blocks translation of an mRNA molecule into a polypeptide (Okano, *J. Neurochem* 56:560 (1991)). The antisense RNA must be of sufficient length and complementarity to prevent translation of its target mRNA.

The heterologous polynucleotides can also code for therapeutic polypeptides. Therapeutic polypeptides include those that can compensate for defective or deficient polypeptide in an animal, or those that act through toxic effects to limit or remove harmful cells from the body. In the present invention, the therapeutic polypeptide comprise KGF-2 polypeptides.

Thus, for example, cells from a patient may be engineered with a polynucleotide (DNA or RNA) comprising KGF-2 polynucleotide operably linked to a promoter *ex vivo*, with the engineered cells then being provided to a patient to be treated with the KGF-2 polypeptide. Such methods are well-known in the art. For example, see Belldegrün, A., *et al.*, *J. Natl. Cancer Inst.* 85: 207-216 (1993); Ferrantini, M. *et al.*, *Cancer Research* 53: 1107-1112 (1993); Ferrantini, M. *et al.*, *J. Immunology* 153: 4604-4615 (1994); Kaido, T., *et al.*, *Int. J. Cancer* 60: 221-229 (1995); Ogura, H., *et al.*, *Cancer Research* 50: 5102-5106 (1990); Santodonato, L., *et al.*, *Human Gene Therapy* 7:1-10 (1996); Santodonato, L., *et al.*, *Gene Therapy* 4:1246-1255 (1997); and Zhang, J.-F. *et al.*, *Cancer Gene Therapy* 3: 31-38 (1996)). The cells to be engineered may be any cell type where KGF-2 may have a therapeutic effect. Such cells include, but are not limited to, muscle cells, epithelial cells, bladder, prostate, testes, lacrimal gland, salivary gland, sinus epithelia, conjunctiva, bone marrow stem and progenitor cells, lung, liver, pancreas, esophagus, etc. . . These engineered cells may be reintroduced into the patient through direct injection to the tissue of origin, the tissues surrounding the tissue of origin, veins or arteries; or through catheter injection.

Similarly, cells may be engineered *in vivo* for expression of a therapeutic polypeptide *in vivo* by, for example, procedures known in the art. The constructs can be delivered by any method that delivers materials to the cells of an animal, such as injection into the interstitial space of tissues. The constructs may be delivered in a pharmaceutically acceptable liquid or aqueous carrier well known to those skilled in the art.

In certain embodiments, the KGF-2 polynucleotide constructs may be delivered as naked polynucleotides. By "naked" polynucleotides is meant that the polynucleotides are free from any delivery vehicle that acts to assist, promote, or

facilitate entry into the cell, including viral sequences, viral particles, liposome formulation, lipofectin, precipitating agents and the like. Such methods are well known in the art and described, for example, in U.S. Patent Nos. 5,593,972, 5,589,466, and 5,580,859.

5 The naked polynucleotides used in the invention can be those which do not integrate into the genome of the host cell. These may be non-replicating sequences, or specific replicating sequences genetically engineered to lack the genome-integration ability. Alternatively, the naked polynucleotides used in the invention may integrate into the genome of the host cell by, for example,
10 homologous recombination, as discussed below. Preferably, the naked KGF-2 polynucleotide construct is contained in a plasmid. Suitable expression vectors for include, but are not limited to, vectors such as pRSVcat (ATCC 37152), pSVL and MSG (Pharmacia, Uppsala, Sweden), pSV2dhfr (ATCC 37146) and pBC12MI (ATCC 67109). Additional suitable plasmids are discussed in more
15 detail above.

 The naked polynucleotides can be administered to any tissue (such as muscle tissue) or organ, as described above. In another embodiment, the naked polynucleotides are administered to the tissue surrounding the tissue of origin. In another embodiment, the naked polynucleotides are administered systemically,
20 through intravenous injection.

 The naked polynucleotides are delivered by any method known in the art, including, but not limited to, direct needle injection at the delivery site, intravenous injection (especially portal vein injection), topical administration, catheter infusion, and so-called "gene guns". These delivery methods are known
25 in the art and discussed in more detail below.

 For naked polynucleotide injection, an effective dosage amount of polynucleotide will be in the range of from about 0.05 μ g/kg body weight to about 50 mg/kg body weight. Preferably, the dosage will be from about 0.005 mg/kg to about 20 mg/kg and more preferably from about 0.05 mg/kg to about 5
30 mg/kg. The appropriate and effective dosage of the polynucleotide construct can readily be determined by those of ordinary skill in the art and may depend on the

condition being treated and the route of administration.

The constructs may also be delivered with delivery vehicles such as viral sequences, viral particles, liposome formulations, lipofectin, precipitating agents, etc. Such methods of delivery are known in the art. For example, the
5 polynucleotide construct can be delivered specifically to hepatocytes through the method of Wu *et al.*, *J. Biol. Chem.* 264:6985-16987 (1989).

In certain embodiments, the KGF-2 polynucleotide constructs are complexed in a liposome preparation. Liposomal preparations for use in the instant invention include cationic (positively charged), anionic (negatively
10 charged) and neutral preparations. However, cationic liposomes are particularly preferred because a tight charge complex can be formed between the cationic liposome and the polyanionic nucleic acid. Cationic liposomes have been shown to mediate intracellular delivery of plasmid DNA (Felgner *et al.*, *Proc. Natl. Acad. Sci. USA* (1987) 84:7413-7416); mRNA (Malone *et al.*, *Proc. Natl. Acad. Sci. USA* (1989) 86:6077-6081); and purified transcription factors (Debs *et al.*,
15 *J. Biol. Chem.* (1990) 265:10189-10192), in functional form.

Cationic liposomes are readily available. For example, N[1-2,3-dioleoyloxy)propyl]-N,N,N-triethylammonium (DOTMA) liposomes are particularly useful and are available under the trademark Lipofectin, from GIBCO
20 BRL, Grand Island, N.Y. (See, also, Felgner *et al.*, *Proc. Natl. Acad. Sci. USA* (1987) 84:7413-7416). Other commercially available liposomes include transfectace (DDAB/DOPE) and DOTAP/DOPE (Boehringer).

Other cationic liposomes can be prepared from readily available materials using techniques well known in the art. See, e.g. PCT Publication No. WO
25 90/11092 for a description of the synthesis of DOTAP (1,2-bis(oleoyloxy)-3-(trimethylammonio)propane) liposomes. Preparation of DOTMA liposomes is explained in the literature, see, e.g., P. Felgner *et al.*, *Proc. Natl. Acad. Sci. USA* 84:7413-7417. Similar methods can be used to prepare liposomes from other cationic lipid materials.

30 Similarly, anionic and neutral liposomes are readily available, such as from Avanti Polar Lipids (Birmingham, Ala.), or can be easily prepared using

readily available materials. Such materials include phosphatidyl, choline, cholesterol, phosphatidyl ethanolamine, dioleoylphosphatidyl choline (DOPC), dioleoylphosphatidyl glycerol (DOPG), dioleoylphosphatidyl ethanolamine (DOPE), among others. These materials can also be mixed with the DOTMA and DOTAP starting materials in appropriate ratios. Methods for making liposomes using these materials are well known in the art.

For example, commercially dioleoylphosphatidyl choline (DOPC), dioleoylphosphatidyl glycerol (DOPG), and dioleoylphosphatidyl ethanolamine (DOPE) can be used in various combinations to make conventional liposomes, with or without the addition of cholesterol. Thus, for example, DOPG/DOPC vesicles can be prepared by drying 50 mg each of DOPG and DOPC under a stream of nitrogen gas into a sonication vial. The sample is placed under a vacuum pump overnight and is hydrated the following day with deionized water. The sample is then sonicated for 2 hours in a capped vial, using a Heat Systems model 350 sonicator equipped with an inverted cup (bath type) probe at the maximum setting while the bath is circulated at 15°C. Alternatively, negatively charged vesicles can be prepared without sonication to produce multilamellar vesicles or by extrusion through nucleopore membranes to produce unilamellar vesicles of discrete size. Other methods are known and available to those of skill in the art.

The liposomes can comprise multilamellar vesicles (MLVs), small unilamellar vesicles (SUVs), or large unilamellar vesicles (LUVs), with SUVs being preferred. The various liposome-nucleic acid complexes are prepared using methods well known in the art. See, e.g., Straubinger *et al.*, *Methods of Immunology* (1983), 101:512-527. For example, MLVs containing nucleic acid can be prepared by depositing a thin film of phospholipid on the walls of a glass tube and subsequently hydrating with a solution of the material to be encapsulated. SUVs are prepared by extended sonication of MLVs to produce a homogeneous population of unilamellar liposomes. The material to be entrapped is added to a suspension of preformed MLVs and then sonicated. When using liposomes containing cationic lipids, the dried lipid film is resuspended in an

appropriate solution such as sterile water or an isotonic buffer solution such as 10 mM Tris/NaCl, sonicated, and then the preformed liposomes are mixed directly with the DNA. The liposome and DNA form a very stable complex due to binding of the positively charged liposomes to the cationic DNA. SUVs find use with small nucleic acid fragments. LUVs are prepared by a number of methods, well known in the art. Commonly used methods include Ca^{2+} -EDTA chelation (Papahadjopoulos *et al.*, *Biochim. Biophys. Acta* (1975) 394:483; Wilson *et al.*, *Cell* (1979) 17:77); ether injection (Deamer, D. and Bangham, A., *Biochim. Biophys. Acta* (1976) 443:629; Ostro *et al.*, *Biochem. Biophys. Res. Commun.* (1977) 76:836; Fraley *et al.*, *Proc. Natl. Acad. Sci. USA* (1979) 76:3348); detergent dialysis (Enoch, H. and Strittmatter, P., *Proc. Natl. Acad. Sci. USA* (1979) 76:145); and reverse-phase evaporation (REV) (Fraley *et al.*, *J. Biol. Chem.* (1980) 255:10431; Szoka, F. and Papahadjopoulos, D., *Proc. Natl. Acad. Sci. USA* (1978) 75:145; Schaefer-Ridder *et al.*, *Science* (1982) 215:166).

Additional examples of useful cationic lipids include dipalmitoyl-phosphatidylethanolamine 5-carboxyspen-nylamide (DPPES); 5-carboxyspermylglycine dioctadecylamide (DOGS); dimethyldioctdecylammonium bromide (DDAB); and (\pm)-N,N-dimethyl-N-[2-(sperminecarboxamido)ethyl]-2,3-bis(dioleyloxy)-1-propaniminium pentahydrochloride (DOSPA). Non-diether cationic lipids, such as DL-1,2-dioleoyl-3-dimethylaminopropyl- β -hydroxyethylammonium (DORI diester), 1,2-O-dioleoyl-3-dimethylaminopropyl- β -hydroxyethylammonium (DORIE diether), 1-O-oleyl-2-oleoyl-3-dimethylaminopropyl- β -hydroxyethylammonium (DORI ester/ether), and their salts promote *in vivo* gene delivery. Cationic cholesterol derivatives such as, {3 β [N-N',N'-dimethylamino]ethane]-carbomoyl}-cholesterol (DC-Chol), are also useful.

Preferred cationic lipids include: (\pm)-N-(2-hydroxyethyl)-N,N-dimethyl-2,3-bis(tetradecyloxy)-1-propaniminium bromide; 3,5-(N,N-di-lysyl)diaminobenzoylglycyl-3-(DL-1,2-dioleoyl-dimethylaminopropyl- β -hydroxyethylamine) (DLYS-DABA-GLY-DORI diester); 3,5-(NN-dilysyl)-diaminobenzoyl-3-(DL-1,2-dioleoyl-dimethylaminopropyl- β -hydroxyethylamine) (DLYS-DABA-DORI

diester); and 1,2-dioleoyl-sn-glycero-3-phosphoethanolamine. Also preferred is the combinations of the following lipids: (\pm)-N-(2-hydroxyethyl)-N,N-dimethyl-2,3-bis(tetradecyloxy)-1-propaniminium bromide and 1,2-dioleoyl-sn-glycero-3-phosphoethanolamine; and (\pm)-N-(2-hydroxyethyl)-N,N-dimethyl-2,3-bis(tetradecyloxy)-1-propaniminium bromide, and 1,2-dioleoyl-sn-glycero-3-phosphoethanolamine in a 1:1 ratio.

The lipid formulations may have a cationic lipid alone, or also include a neutral lipid such as cardiolipin, phosphatidylcholine, phosphatidylethanolamine, dioleoylphosphatylcholine, dioleoylphosphatidyl-ethanolamine, 1,2-dioleoyl-sn-glycero-3-phosphatidylethanolamine (DOPE), sphingomyelin, and mono-, di- or tri-acylglycerol).

Lipid formulations may also have cationic lipid together with a lysophosphatide. The lysophosphatide may have a neutral or a negative head group. Useful lysophosphatides include lysophosphatidylcholine, lysophosphatidyl-ethanolamine, and 1-oleoyl lysophosphatidylcholine. Lysophosphatide lipids are present. Other additives, such as cholesterol, fatty acid, ganglioside, glycolipid, neobee, niosome, prostaglandin, sphingolipid, and any other natural or synthetic amphiphiles, can be used. A preferred molar ratio of cationic lipid to neutral lipid in these lipid formulations is from about 9:1 to about 1:9; an equimolar ratio is more preferred in the lipid-containing formulation in a 1:2 ratio of lysolipid to cationic lipid.

Generally, the ratio of DNA to liposomes will be from about 10:1 to about 1:10. Preferably, the ratio will be from about 5:1 to about 1:5. More preferably, the ratio will be about 3:1 to about 1:3. Still more preferably, the ratio will be about 1:1.

U.S. Patent No. 5,676,954 reports on the injection of genetic material, complexed with cationic liposomes carriers, into mice. U.S. Patent Nos. 4,897,355, 4,946,787, 5,049,386, 5,459,127, 5,589,466, 5,693,622, 5,580,859, 5,703,055, and international publication no. WO 94/9469 provide cationic lipids for use in transfecting DNA into cells and mammals. U.S. Patent Nos. 5,589,466, 5,693,622, 5,580,859, 5,703,055, and international publication no. WO 94/9469

provide methods for delivering DNA-cationic lipid complexes to mammals.

In certain embodiments, cells are be engineered, *ex vivo* or *in vivo*, using a retroviral particle containing RNA which comprises a polynucleotide encoding KGF-2 operably linked to a promoter. Retroviruses from which the retroviral
5 plasmid vectors may be derived include, but are not limited to, Moloney Murine Leukemia Virus, spleen necrosis virus, Rous sarcoma Virus, Harvey Sarcoma Virus, avian leukosis virus, gibbon ape leukemia virus, human immunodeficiency virus, Myeloproliferative Sarcoma Virus, and mammary tumor virus.

The retroviral plasmid vector is employed to transduce packaging cell
10 lines to form producer cell lines. Examples of packaging cells which may be transfected include, but are not limited to, the PE501, PA317, ψ -2, ψ -AM, PA12, T19-14X, VT-19-17-H2, ψ CRE, ψ CRIP, GP+E-86, GP+envAm12, and DAN cell lines as described in Miller, *Human Gene Therapy* 1:5-14 (1990), which is incorporated herein by reference in its entirety. The vector may transduce the
15 packaging cells through any means known in the art. Such means include, but are not limited to, electroporation, the use of liposomes, and CaPO_4 precipitation. In one alternative, the retroviral plasmid vector may be encapsulated into a liposome, or coupled to a lipid, and then administered to a host.

The producer cell line generates infectious retroviral vector particles
20 which include a KGF-2 polynucleotide operably linked to a promoter. Such retroviral vector particles then may be employed, to transduce eukaryotic cells, either *in vitro* or *in vivo*. The transduced eukaryotic cells will express the desired polypeptide.

In certain other embodiments, cells are engineered, *ex vivo* or *in vivo*, with
25 the KGF-2 polynucleotide operably linked to a promoter contained in an adenovirus vector. Adenovirus can be manipulated such that it encodes and expresses the desired gene product, and at the same time is inactivated in terms of its ability to replicate in a normal lytic viral life cycle. Adenovirus expression is achieved without integration of the viral DNA into the host cell chromosome,
30 thereby alleviating concerns about insertional mutagenesis. Furthermore, adenoviruses have been used as live enteric vaccines for many years with an

excellent safety profile (Schwartz, A. R. *et al.* (1974) *Am. Rev. Respir. Dis.* 109:233-238). Finally, adenovirus mediated gene transfer has been demonstrated in a number of instances including transfer of alpha-1-antitrypsin and CFTR to the lungs of cotton rats (Rosenfeld, M. A. *et al.* (1991) *Science* 252:431-434; Rosenfeld *et al.*, (1992) *Cell* 68:143-155). Furthermore, extensive studies to attempt to establish adenovirus as a causative agent in human cancer were uniformly negative (Green, M. *et al.* (1979) *Proc. Natl. Acad. Sci. USA* 76:6606).

Suitable adenoviral vectors useful in the present invention are described, for example, in Kozarsky and Wilson, *Curr. Opin. Genet. Devel.* 3:499-503 (1993); Rosenfeld *et al.*, *Cell* 68:143-155 (1992); Engelhardt *et al.*, *Human Genet. Ther.* 4:759-769 (1993); Yang *et al.*, *Nature Genet.* 7:362-369 (1994); Wilson *et al.*, *Nature* 365:691-692 (1993); and U.S. Patent No. 5,652,224, which are herein incorporated by reference. For example, the adenovirus vector Ad2 is useful and can be grown in human 293 cells. These cells contain the E1 region of adenovirus and constitutively express E1a and E1b, which complement the defective adenoviruses by providing the products of the genes deleted from the vector. In addition to Ad2, other varieties of adenovirus (e.g., Ad3, Ad5, and Ad7) are also useful in the present invention.

Preferably, the adenoviruses used in the present invention are replication deficient. Replication deficient adenoviruses require the aid of a helper virus and/or packaging cell line to form infectious particles. The resulting virus is capable of infecting cells and can express a polynucleotide of interest which is operably linked to a promoter, for example, the KGF-2 polynucleotide of the present invention, but cannot replicate in most cells. Replication deficient adenoviruses may be deleted in one or more of all or a portion of the following genes: E1a, E1b, E3, E4, E2a, or L1 through L5.

In certain other embodiments, the cells are engineered, *ex vivo* or *in vivo*, using an adeno-associated virus (AAV). AAVs are naturally occurring defective viruses that require helper viruses to produce infectious particles (Muzyczka, N., *Curr. Topics in Microbiol. Immunol.* 158:97 (1992)). It is also one of the few

viruses that may integrate its DNA into non-dividing cells. Vectors containing as little as 300 base pairs of AAV can be packaged and can integrate, but space for exogenous DNA is limited to about 4.5 kb. Methods for producing and using such AAVs are known in the art. See, for example, U.S. Patent Nos. 5,139,941,
5 5,173,414, 5,354,678, 5,436,146, 5,474,935, 5,478,745, and 5,589,377.

For example, an appropriate AAV vector for use in the present invention will include all the sequences necessary for DNA replication, encapsidation, and host-cell integration. The KGF-2 polynucleotide construct is inserted into the AAV vector using standard cloning methods, such as those found in Sambrook
10 *et al.*, *Molecular Cloning: A Laboratory Manual*, Cold Spring Harbor Press (1989). The recombinant AAV vector is then transfected into packaging cells which are infected with a helper virus, using any standard technique, including lipofection, electroporation, calcium phosphate precipitation, etc. Appropriate helper viruses include adenoviruses, cytomegaloviruses, vaccinia viruses, or
15 herpes viruses. Once the packaging cells are transfected and infected, they will produce infectious AAV viral particles which contain the KGF-2 polynucleotide construct. These viral particles are then used to transduce eukaryotic cells, either *ex vivo* or *in vivo*. The transduced cells will contain the KGF-2 polynucleotide construct integrated into its genome, and will express the molecule of interest.

Another method of gene therapy involves operably associating heterologous control regions (e.g., a promoter of interest) and endogenous polynucleotide sequences (e.g., KGF-2) via homologous recombination (see, e.g., U.S. Patent No. 5,641,670, issued June 24, 1997; International Publication No. WO 96/29411, published September 26, 1996; International Publication No. WO
20 94/12650, published August 4, 1994; Koller *et al.*, *Proc. Natl. Acad. Sci. USA* 86:8932-8935 (1989); and Zijlstra *et al.*, *Nature* 342:435-438 (1989). This method involves the activation of a gene which is present in the target cells, but which is not normally expressed in the cells, or is expressed at a lower level than desired.

Polynucleotide constructs are made, using standard techniques known in
30 the art, which contain the promoter of interest with targeting sequences flanking

the promoter of interest. The targeting sequence is sufficiently complementary to an endogenous sequence to permit homologous recombination of the promoter-targeting sequence with the endogenous sequence. The targeting sequence will be sufficiently near the 5' end of the desired endogenous polynucleotide sequence so the promoter will be operably linked to the endogenous sequence upon homologous recombination. The promoter and the targeting sequences can be amplified using PCR. Preferably, the amplified promoter contains distinct restriction enzyme sites on the 5' and 3' ends. Preferably, the 3' end of the first targeting sequence contains the same restriction enzyme site as the 5' end of the amplified promoter and the 5' end of the second targeting sequence contains the same restriction site as the 3' end of the amplified promoter. The amplified promoter and targeting sequences are digested and ligated together.

The promoter-targeting sequence construct is delivered to the cells, either as naked polynucleotide, or in conjunction with transfection-facilitating agents, such as liposomes, viral sequences, viral particles, whole viruses, lipofection, precipitating agents, etc., described in more detail above. The promoter-targeting sequence can be delivered by any method, included direct needle injection, intravenous injection, topical administration, catheter infusion, particle accelerators, etc. The methods are described in more detail below.

The promoter-targeting sequence construct is taken up by cells. Homologous recombination between the construct and the endogenous sequence takes place, such that an endogenous sequence (e.g., KGF-2) is placed under the control of the promoter. The promoter then drives the expression of the endogenous sequence (e.g., KGF-2).

KGF-2 polynucleotides of the present invention may be used in gene therapy to treat metabolic, infectious and other diseases described herein. Preferably, a KGF-2 polynucleotide of the present invention is operably linked a promoter so as to alleviate the symptoms of, or cures the disease to be treated as described in detail herein.

Any mode of administration of any of the above-described polynucleotides constructs can be used so long as the mode results in the

expression of one or more molecules in an amount sufficient to provide a therapeutic effect. This includes direct needle injection, systemic injection, catheter infusion, biolistic injectors, particle accelerators (i.e., "gene guns"), gelfoam sponge depots, other commercially available depot materials, osmotic pumps (e.g., Alza minipumps), oral or suppositorial solid (tablet or pill) pharmaceutical formulations, and decanting or topical applications during surgery. For example, direct injection of naked calcium phosphate-precipitated plasmid into rat liver and rat spleen or a protein-coated plasmid into the portal vein has resulted in gene expression of the foreign gene in the rat livers (Kaneda *et al.*, *Science* 243:375 (1989)).

A preferred method of local administration is by direct injection. Preferably, a recombinant molecule of the present invention complexed with a delivery vehicle is administered by direct injection into or locally within the area of the liver. Administration of a composition locally within the area of the liver refers to injecting the composition centimeters and preferably, millimeters within the liver.

Another method of local administration is to contact a KGF-2 polynucleotide-promoter construct of the present invention in or around a surgical wound. For example, a patient can undergo surgery and the polynucleotide construct can be coated on the surface of tissue inside the wound or the construct can be injected into areas of tissue inside the wound.

Therapeutic compositions useful in systemic administration, include recombinant molecules of the present invention complexed to a targeted delivery vehicle of the present invention. Suitable delivery vehicles for use with systemic administration comprise liposomes comprising ligands for targeting the vehicle to a particular site, for example, ligands for targeting the vehicle to a tissue of interest. Targeting vehicles for other tissues and organs are well known to skilled artisans.

Preferred methods of systemic administration, include intravenous injection, aerosol, oral and percutaneous (topical) delivery. Intravenous injections can be performed using methods standard in the art. Aerosol delivery can also be

performed using methods standard in the art (see, for example, Stribling *et al.*, *Proc. Natl. Acad. Sci. USA* 189:11277-11281, 1992, which is incorporated herein by reference). Oral delivery can be performed by complexing a polynucleotide construct of the present invention to a carrier capable of withstanding degradation
5 by digestive enzymes in the gut of an animal. Examples of such carriers, include plastic capsules or tablets, such as those known in the art. Topical delivery can be performed by mixing a polynucleotide construct of the present invention with a lipophilic reagent (e.g., DMSO) that is capable of passing into the skin.

Determining an effective amount of substance to be delivered can depend
10 upon a number of factors including, for example, the chemical structure and biological activity of the substance, the age and weight of the animal, the precise condition requiring treatment and its severity, and the route of administration. The frequency of treatments depends upon a number of factors, such as the amount of polynucleotide constructs administered per dose, as well as the health
15 and history of the subject. The precise amount, number of doses, and timing of doses will be determined by the attending physician or veterinarian.

Therapeutic compositions of the present invention can be administered to
any animal, preferably to mammals and birds. Preferred mammals include
humans, dogs, cats, mice, rats, rabbits sheep, cattle, horses and pigs, with humans
20 being particularly preferred.

Example 1

Bacterial Expression and Purification of KGF-2

The DNA sequence encoding KGF-2, ATCC # 75977, is initially
amplified using PCR oligonucleotide primers corresponding to the 5' and 3' end
25 sequences of the processed KGF-2 cDNA (including the signal peptide sequence).

The 5' oligonucleotide primer has the sequence

5' CCCCACATGTGGAAATGGATACTGACACATTGTGCC 3' (SEQ ID
No. 3) contains an Afl III restriction enzyme site including and followed by 30

nucleotides of KGF-2 coding sequence starting from the presumed initiation codon. The 3' sequence
5' CCCAAGCTTCCACAAACGTTGCCTTCCTCTATGAG 3' (SEQ ID No. 4)
contains complementary sequences to Hind III site and is followed by 26
5 nucleotides of KGF-2. The restriction enzyme sites are compatible with the
restriction enzyme sites on the bacterial expression vector pQE-60 (Qiagen, Inc.
Chatsworth, CA). pQE-60 encodes antibiotic resistance (Amp^r), a bacterial
origin of replication (ori), an IPTG-regulatable promoter operator (P/O), a
ribosome binding site (RBS), a 6-His tag and restriction enzyme sites. pQE-60
10 is then digested with NcoI and HindIII. The amplified sequences are ligated into
pQE-60 and are inserted in frame. The ligation mixture is then used to transform
E. coli strain M15/rep 4 (Qiagen, Inc.) by the procedure described in Sambrook,
J., *et al.*, *Molecular Cloning: A Laboratory Manual*, Cold Spring Laboratory
Press, (1989). M15/rep4 contains multiple copies of the plasmid pREP4, which
15 expresses the lacI repressor and also confers kanamycin resistance (Kan^r).
Transformants are identified by their ability to grow on LB plates and
ampicillin/kanamycin resistant colonies are selected. Plasmid DNA is isolated
and confirmed by restriction analysis. Clones containing the desired constructs
are grown overnight (O/N) in liquid culture in LB media supplemented with both
20 Amp (100 ug/ml) and Kan (25 ug/ml). The O/N culture is used to inoculate a
large culture at a ratio of 1:100 to 1:250. The cells are grown to an optical density
600 (O.D.⁶⁰⁰) of between 0.4 and 0.6. IPTG ("Isopropyl-B-D-thiogalacto
pyranoside") is then added to a final concentration of 1 mM. IPTG interacts with
the lacI repressor to cause it to dissociate from the operator, forcing the promoter
25 to direct transcription. Cells are grown an extra 3 to 4 hours. Cells are then
harvested by centrifugation. The cell pellet is solubilized in the chaotropic agent
6 Molar Guanidnine HCl. After clarification, solubilized KGF-2 is purified from
this solution by chromatography on a Heparin affinity column under conditions
that allow for tight binding of the proteins (Hochuli, E., *et al.*, *J. Chromatography*
30 411:177-184 (1984)). KGF-2 (75% pure) is eluted from the column by high salt
buffer.

Example 2

Bacterial Expression and Purification of a Truncated Version of KGF-2

The DNA sequence encoding KGF-2, ATCC # 75977, is initially amplified using PCR oligonucleotide primers corresponding to the 5' and 3' sequences of the truncated version of the KGF-2 polypeptide. The truncated version comprises the polypeptide minus the 36 amino acid signal sequence, with a methionine and alanine residue being added just before the cysteine residue which comprises amino acid 37 of the full-length protein. The 5' oligonucleotide primer has the sequence

5' CATGCCATGGCGTGCCAAGCCCTTGGTCAGGACATG 3' (SEQ ID No. 5) contains an NcoI restriction enzyme site including and followed by 24 nucleotides of KGF-2 coding sequence. The 3' sequence

5' CCAAGCTTCCACAAACGTTGCCTTCCTC TATGAG 3' (SEQ ID No. 6) contains complementary sequences to Hind III site and is followed by 26 nucleotides of the KGF-2 gene. The restriction enzyme sites are compatible with the restriction enzyme sites on the bacterial expression vector pQE-60 (Qiagen, Inc. Chatsworth, CA). pQE-60 encodes antibiotic resistance (Amp^r), a bacterial origin of replication (ori), an IPTG-regulatable promoter operator (P/O), a ribosome binding site (RBS), a 6-His tag and restriction enzyme sites. pQE-60 is then digested with NcoI and HindIII. The amplified sequences are ligated into pQE-60 and are inserted in frame. The ligation mixture is then used to transform *E. coli* strain M15/rep 4 (Qiagen, Inc.) by the procedure described in Sambrook, J., et al., *Molecular Cloning: A Laboratory Manual*, Cold Spring Laboratory Press, (1989). M15/rep4 contains multiple copies of the plasmid pREP4, which expresses the lacI repressor and also confers kanamycin resistance (Kan^r). Transformants are identified by their ability to grow on LB plates and ampicillin/kanamycin resistant colonies are selected. Plasmid DNA is isolated and confirmed by restriction analysis. Clones containing the desired constructs are grown overnight (O/N) in liquid culture in LB media supplemented with both

-100-

Amp (100 ug/ml) and Kan (25 ug/ml). The O/N culture is used to inoculate a large culture at a ratio of 1:100 to 1:250. The cells are grown to an optical density 600 (O.D.⁶⁰⁰) of between 0.4 and 0.6. IPTG ("Isopropyl-B-D-thiogalactopyranoside") is then added to a final concentration of 1 mM. IPTG induces by inactivating the lacI repressor, clearing the P/O leading to increased gene expression. Cells are grown an extra 3 to 4 hours. Cells are then harvested by centrifugation. The cell pellet is solubilized in the chaotropic agent 6 Molar Guanidine HCl. After clarification, solubilized KGF-2 is purified from this solution by chromatography on a Heparin affinity column under conditions that allow for tight binding the proteins (Hochuli, E. *et al.*, *J. Chromatography* 411:177-184 (1984)). KGF-2 protein is eluted from the column by high salt buffer.

Example 3

Cloning and Expression of KGF-2 Using the Baculovirus Expression System

The DNA sequence encoding the full length KGF-2 protein, ATCC # 75977, is amplified using PCR oligonucleotide primers corresponding to the 5' and 3' sequences of the gene:

The 5' primer has the sequence

5' GCGGGATCCGCCATCATGTGGAAATGGATACTCAC 3' (SEQ ID No. 7) and contains a BamHI restriction enzyme site (in bold) followed by 6 nucleotides resembling an efficient signal for the initiation of translation in eukaryotic cells (Kozak, M., *J. Mol. Biol.*, 196:947-950 (1987)) and just behind the first 17 nucleotides of the KGF-2 gene (the initiation codon for translation "ATG" is underlined).

The 3' primer has the sequence

5' GCGCGGTACCACAAACGTTGCCTTCCT 3' (SEQ ID No. 8) and contains the cleavage site for the restriction endonuclease Asp718 and 19 nucleotides complementary to the 3' non-translated sequence of the KGF-2 gene. The

amplified sequences are isolated from a 1% agarose gel using a commercially available kit from Qiagen, Inc., Chatsworth, CA. The fragment is then digested with the endonucleases BamHI and Asp718 and then purified again on a 1% agarose gel. This fragment is designated F2.

5 The vector pA2 (modification of pVL941 vector, discussed below) is used for the expression of the KGF-2 protein using the baculovirus expression system (for review see: Summers, M.D. & Smith, G.E., *A manual of methods for baculovirus vectors and insect cell culture procedures*, Texas Agricultural Experimental Station Bulletin No. 1555 (1987)). This expression vector contains
10 the strong polyhedrin promoter of the Autographa californica nuclear polyhidrosis virus (AcMNPV) followed by the recognition sites for the restriction endonucleases BamHI and Asp718. The polyadenylation site of the simian virus (SV) 40 is used for efficient polyadenylation. For an easy selection of recombinant viruses the beta-galactosidase gene from *E. coli* is inserted in the
15 same orientation as the polyhedrin promoter followed by the polyadenylation signal of the polyhedrin gene. The polyhedrin sequences are flanked at both sides by viral sequences for the cell-mediated homologous recombination of co-transfected wild-type viral DNA. Many other baculovirus vectors could be used such as pAc373, pVL941 and pAcIM1 (Luckow, V.A. & Summers, M.D.,
20 *Virology*, 170:31-39).

 The plasmid is digested with the restriction enzymes BamHI and Asp718. The DNA is then isolated from a 1% agarose gel using the commercially available kit (Qiagen, Inc., Chatsworth, CA). This vector DNA is designated V2.

 Fragment F2 and the plasmid V2 are ligated with T4 DNA ligase. *E. coli*
25 HB101 cells are then transformed and bacteria identified that contained the plasmid (pBacKGF-2) with the KGF-2 gene using PCR with both cloning oligonucleotides. The sequence of the cloned fragment is confirmed by DNA sequencing.

 5 µg of the plasmid pBacKGF-2 is co-transfected with 1.0 µg of a
30 commercially available linearized baculovirus ("BaculoGold™ baculovirus DNA", Pharmingen, San Diego, CA) using the lipofection method (Felgner, *et al.*,

Proc. Natl. Acad. Sci. USA, 84:7413-7417 (1987)).

1 µg of BaculoGold™ virus DNA and 5 µg of the plasmid pBacKGF-2 are mixed in a sterile well of a microtiter plate containing 50 µl of serum free Grace's medium (Life Technologies Inc., Gaithersburg, MD). Afterwards 10 µl
5 Lipofectin plus 90 µl Grace's medium are added, mixed and incubated for 15 minutes at room temperature. Then the transfection mixture is added drop-wise to the Sf9 insect cells (ATCC CRL 1711) seeded in a 35 mm tissue culture plate with 1 ml Grace's medium without serum. The plate is rocked back and forth to mix the newly added solution. The plate is then incubated for 5 hours at 27°C.
10 After 5 hours the transfection solution is removed from the plate and 1 ml of Grace's insect medium supplemented with 10% fetal calf serum is added. The plate is put back into an incubator and cultivation continued at 27°C for four days.

After four days the supernatant is collected and a plaque assay performed
15 similar as described by Summers and Smith (supra). As a modification an agarose gel with "Blue Gal" (Life Technologies Inc., Gaithersburg) is used which allows an easy isolation of blue stained plaques. (A detailed description of a "plaque assay" can also be found in the user's guide for insect cell culture and baculovirology distributed by Life Technologies Inc., Gaithersburg, page 9-10).

20 Four days after the serial dilution, the viruses are added to the cells and blue stained plaques are picked with the tip of an Eppendorf pipette. The agar containing the recombinant viruses is then resuspended in an Eppendorf tube containing 200 µl of Grace's medium. The agar is removed by a brief centrifugation and the supernatant containing the recombinant baculovirus is used
25 to infect Sf 9 cells seeded in 35 mm dishes. Four days later the supernatants of these culture dishes are harvested and then stored at 4°C.

Sf9 cells are grown in Grace's medium supplemented with 10% heat-inactivated FBS. The cells are infected with the recombinant baculovirus V-KGF-2 at a multiplicity of infection (MOI) of 2. Six hours later the medium is removed and replaced with SF900 II medium minus methionine and cysteine
30 (Life Technologies Inc., Gaithersburg). 42 hours later 5 µCi of ³⁵S methionine

and 5 μCi ^{35}S cysteine (Amersham) are added. The cells are further incubated for 16 hours before they are harvested by centrifugation and the labelled proteins visualized by SDS-PAGE and autoradiography.

Example 4

5 Most of the vectors used for the transient expression of the KGF-2 protein gene sequence in mammalian cells should carry the SV40 origin of replication. This allows the replication of the vector to high copy numbers in cells (e.g., COS cells) which express the T antigen required for the initiation of viral DNA synthesis. Any other mammalian cell line can also be utilized for this purpose.

10 A typical mammalian expression vector contains the promoter element, which mediates the initiation of transcription of mRNA, the protein coding sequence, and signals required for the termination of transcription and polyadenylation of the transcript. Additional elements include enhancers, Kozak sequences and intervening sequences flanked by donor and acceptor sites for
15 RNA splicing. Highly efficient transcription can be achieved with the early and late promoters from SV40, the long terminal repeats (LTRs) from Retroviruses, e.g., RSV, HTLV, HIV and the immediate early promoter of the cytomegalovirus (CMV). However, cellular signals can also be used (e.g., human actin promoter). Suitable expression vectors for use in practicing the present
20 invention include, for example, vectors such as pSVL and pMSG (Pharmacia, Uppsala, Sweden), pRSVcat (ATCC 37152), pSV2dhfr (ATCC 37146) and pBC12MI (ATCC 67109). Mammalian host cells that could be used include, human Hela, 283, H9 and Jurkat cells, mouse NIH3T3 and C127 cells, Cos 1, Cos 7 and CV1, African green monkey cells, quail QC1-3 cells, 293T cells,
25 mouse L cells and Chinese hamster ovary cells.

 Alternatively, the gene can be expressed in stable cell lines that contain the gene integrated into a chromosome. The co-transfection with a selectable marker such as dhfr, gpt, neomycin, hygromycin allows the identification and isolation of the transfected cells.

The transfected gene can also be amplified to express large amounts of the encoded protein. The DHFR (dihydrofolate reductase) is a useful marker to develop cell lines that carry several hundred or even several thousand copies of the gene of interest. Another useful selection marker is the enzyme glutamine synthase (GS) (Murphy *et al.*, *Biochem J.* 227:277-279 (1991); Bebbington *et al.*, *Bio/Technology* 10:169-175 (1992)). Using these markers, the mammalian cells are grown in selective medium and the cells with the highest resistance are selected. These cell lines contain the amplified gene(s) integrated into a chromosome. Chinese hamster ovary (CHO) cells are often used for the production of proteins.

The expression vectors pC1 and pC4 contain the strong promoter (LTR) of the Rous Sarcoma Virus (Cullen *et al.*, *Molecular and Cellular Biology*, 438-447 (March, 1985)) plus a fragment of the CMV-enhancer (Boshart *et al.*, *Cell* 41:521-530 (1985)). Multiple cloning sites, e.g., with the restriction enzyme cleavage sites BamHI, XbaI and Asp718, facilitate the cloning of the gene of interest. The vectors contain in addition the 3' intron, the polyadenylation and termination signal of the rat preproinsulin gene.

A. Expression of Recombinant KGF-2 in COS Cells

The expression of plasmid, KGF-2 HA was derived from a vector pcDNA1/Amp (Invitrogen) containing: 1) SV40 origin of replication, 2) ampicillin resistance gene, 3) *E. coli* replication origin, 4) CMV promoter followed by a polylinker region, a SV40 intron and polyadenylation site. The HA tag correspond to an epitope derived from the influenza hemagglutinin protein as previously described (Wilson, I., *et al.*, *Cell* 37:767, (1984)). The infusion of HA tag to the target protein allows easy detection of the recombinant protein with an antibody that recognizes the HA epitope. A DNA fragment encoding the entire KGF-2 precursor HA tag fused in frame with the HA tag, therefore, the recombinant protein expression is directed under the CMV promoter.

The plasmid construction strategy is described as follows:

The DNA sequence encoding KGF-2, ATCC # 75977, is constructed by PCR using two primers: the 5' primer

5' TAACGAGGATCCGCCATCATGTGGAAATGGATACTGACAC 3' (SEQ ID No. 9) contains a BamHI site followed by 22 nucleotides of KGF-2 coding sequence starting from the initiation codon; the 3' sequence

5' TAAGCACTCGAGTGAGTGTACCACCATTGGAAGAAATG 3' (SEQ ID No. 10) contains complementary sequences to an XhoI site, HA tag and the last 26 nucleotides of the KGF-2 coding sequence (not including the stop codon).

Therefore, the PCR product contains a BamHI site, KGF-2 coding sequence followed by an XhoI site, an HA tag fused in frame, and a translation termination stop codon next to the HA tag. The PCR amplified DNA fragment and the vector, pcDNA-3'HA, are digested with BamHI and XhoI restriction enzyme and ligated resulting in pcDNA-3'HA-KGF-2. The ligation mixture is transformed into *E. coli* strain XL1 Blue (Stratagene Cloning Systems, La Jolla, CA) the

transformed culture is plated on ampicillin media plates and resistant colonies are selected. Plasmid DNA was isolated from transformants and examined by PCR and restriction analysis for the presence of the correct fragment. For expression of the recombinant KGF-2, COS cells were transfected with the expression vector by DEAE-DEXTRAN method (Sambrook, J., *et al.*, *Molecular Cloning: A Laboratory Manual*, Cold Spring Laboratory Press, (1989)). The expression of the KGF-2 HA protein was detected by radiolabelling and immunoprecipitation method (Harlow, E. & Lane, D., *Antibodies: A Laboratory Manual*, Cold Spring Harbor Laboratory Press, (1988)). Cells were labeled for 8 hours with ³⁵S-cysteine two days post transfection. Culture media were then collected and cells were lysed with detergent (RIPA buffer (150 mM NaCl, 1% NP-40, 0.1% SDS, 1% NP-40, 0.5% DOC, 50mM Tris, pH 7.5) (Wilson, I., *et al.*, *Id.* 37:767 (1984)). Both cell lysate and culture media were precipitated with a HA specific monoclonal antibody. Proteins precipitated were analyzed on 15% SDS-PAGE gels.

B. Expression and purification of human KGF-2 protein using the CHO Expression System

The vector pC1 is used for the expression of KGF-2 protein. Plasmid pC1 is a derivative of the plasmid pSV2-dhfr [ATCC Accession No. 37146]. Both
5 plasmids contain the mouse DHFR gene under control of the SV40 early promoter. Chinese hamster ovary- or other cells lacking dihydrofolate activity that are transfected with these plasmids can be selected by growing the cells in a selective medium (alpha minus MEM, Life Technologies) supplemented with the chemotherapeutic agent methotrexate. The amplification of the DHFR genes in
10 cells resistant to methotrexate (MTX) has been well documented (see, e.g., Alt, F.W., Kellems, R.M., Bertino, J.R., and Schimke, R.T., 1978, J. Biol. Chem. 253:1357-1370, Hamlin, J.L. and Ma, C. 1990, Biochem. et Biophys. Acta, 1097:107-143, Page, M.J. and Sydenham, M.A. 1991, Biotechnology Vol. 9:64-68). Cells grown in increasing concentrations of MTX develop resistance to the
15 drug by overproducing the target enzyme, DHFR, as a result of amplification of the DHFR gene. If a second gene is linked to the DHFR gene it is usually co-amplified and over-expressed. It is state of the art to develop cell lines carrying more than 1,000 copies of the genes. Subsequently, when the methotrexate is withdrawn, cell lines contain the amplified gene integrated into the
20 chromosome(s).

Plasmid pC1 contains for the expression of the gene of interest a strong promoter of the long terminal repeat (LTR) of the Rouse Sarcoma Virus (Cullen, *et al.*, Molecular and Cellular Biology, March 1985:438-4470) plus a fragment
25 isolated from the enhancer of the immediate early gene of human cytomegalovirus (CMV) (Boshart *et al.*, *Cell* 41:521-530, 1985). Downstream of the promoter are the following single restriction enzyme cleavage sites that allow the integration of the genes: BamHI, PvuII, and NruI. Behind these cloning sites the plasmid contains translational stop codons in all three reading frames followed by the 3' intron and the polyadenylation site of the rat preproinsulin
30 gene. Other high efficient promoters can also be used for the expression, e.g., the human β -actin promoter, the SV40 early or late promoters or the long terminal

repeats from other retroviruses, e.g., HIV and HTLV. For the polyadenylation of the mRNA other signals, e.g., from the human growth hormone or globin genes can be used as well.

5 Stable cell lines carrying a gene of interest integrated into the chromosomes can also be selected upon co-transfection with a selectable marker such as gpt, G418 or hygromycin. It is advantageous to use more than one selectable marker in the beginning, e.g., G418 plus methotrexate.

10 The plasmid pC1 is digested with the restriction enzyme BamHI and then dephosphorylated using calf intestinal phosphates by procedures known in the art. The vector is then isolated from a 1% agarose gel.

The DNA sequence encoding KFG-2, ATCC No. 75977, is amplified using PCR oligonucleotide primers corresponding to the 5' and 3' sequences of the gene:

15 The 5' primer has the sequence
5'TAACGAGGATCCGCCATCATGTGGAAATGGATACTGACAC 3' (SEQ ID No. 9) containing the underlined BamHI restriction enzyme site followed by 21 bases of the sequence of KGF-2 of Figure 1 (SEQ ID NO:1). Inserted into an expression vector, as described below, the 5' end of the amplified fragment encoding human KGF-2 provides an efficient signal peptide. An efficient signal
20 for initiation of translation in eukaryotic cells, as described by Kozak, M., J. Mol. Biol. 196:947-950 (1987) is appropriately located in the vector portion of the construct.

The 3' primer has the sequence
25 5'TAAGCAGGATCCTGAGTGTACCACCATTTGGAAGAAATG 3' (SEQ ID NO. 10) containing the BamHI restriction followed by nucleotides complementary to the last 26 nucleotides of the KGF-2 coding sequence set out in Figure 1 (SEQ ID NO:1), not including the stop codon.

The amplified fragments are isolated from a 1% agarose gel as described above and then digested with the endonuclease BamHI and then purified again on
30 a 1% agarose gel.

The isolated fragment and the dephosphorylated vector are then ligated

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with T4 DNA ligase. *E. coli* HB101 cells are then transformed and bacteria identified that contained the plasmid pC1. The sequence and orientation of the inserted gene is confirmed by DNA sequencing.

Transfection of CHO-DHFR-cells

5 Chinese hamster ovary cells lacking an active DHFR enzyme are used for transfection. 5 µg of the expression plasmid C1 are cotransfected with 0.5 µg of the plasmid pSVneo using the lipofecting method (Felgner *et al.*, *supra*). The plasmid pSV2-neo contains a dominant selectable marker, the gene neo from Tn5 encoding an enzyme that confers resistance to a group of antibiotics including
10 G418. The cells are seeded in alpha minus MEM supplemented with 1 mg/ml G418. After 2 days, the cells are trypsinized and seeded in hybridoma cloning plates (Greiner, Germany) and cultivated for 10-14 days. After this period, single clones are trypsinized and then seeded in 6-well petri dishes using different concentrations of methotrexate (25 nM, 50 nM, 100 nM, 200 nM, 400 nM).
15 Clones growing at the highest concentrations of methotrexate are then transferred to new 6-well plates containing even higher concentrations of methotrexate (500 nM, 1 µM, 2 µM, 5 µM). The same procedure is repeated until clones grow at a concentration of 100 µM.

20 The expression of the desired gene product is analyzed by Western blot analysis and SDS-PAGE.

Example 5

Transcription and Translation of Recombinant KGF-2 in vitro

A PCR product is derived from the cloned cDNA in the pA2 vector used for insect cell expression of KGF-2. The primers used for this PCR were:
25 5'ATTAACCCTCACTAAAGGGAGGCCATGTGGAAATGGATACTGACA
CATTGTGCC 3' (SEQ ID No. 11) and

5'CCCAAGCTTCCACAAACGTTGCCTTCCTCTATGAG3'(SEQ ID No. 12).

The first primer contains the sequence of a T3 promoter 5' to the ATG initiation codon. The second primer is complimentary to the 3' end of the KGF-2 open reading frame, and encodes the reverse complement of a stop codon.

5 The resulting PCR product is purified using a commercially available kit from Qiagen. 0.5 µg of this DNA is used as a template for an *in vitro* transcription-translation reaction. The reaction is performed with a kit commercially available from Promega under the name of TNT. The assay is performed as described in the instructions for the kit, using radioactively labeled
10 methionine as a substrate, with the exception that only ½ of the indicated volumes of reagents are used and that the reaction is allowed to proceed at 33 °C for 1.5 hours.

Five µl of the reaction is electrophoretically separated on a denaturing
15 to 15% polyacrylamide gel. The gel is fixed for 30 minutes in a mixture of water:Methanol:Acetic acid at 6:3:1 volumes respectively. The gel is then dried under heat and vacuum and subsequently exposed to an X-ray film for 16 hours. The film is developed showing the presence of a radioactive protein band corresponding in size to the conceptually translated KGF-2, strongly suggesting that the cloned cDNA for KGF-2 contains an open reading frame that codes for
20 a protein of the expected size.

Example 6

Expression via Gene Therapy

Fibroblasts are obtained from a subject by skin biopsy. The resulting tissue is placed in tissue-culture medium and separated into small pieces. Small
25 chunks of the tissue are placed on a wet surface of a tissue culture flask, approximately ten pieces are placed in each flask. The flask is turned upside down, closed tight and left at room temperature over night. After 24 hours at room temperature, the flask is inverted and the chunks of tissue remain fixed to

the bottom of the flask and fresh media (e.g., Ham's F12 media, with 10% FBS, penicillin and streptomycin, is added.) This is then incubated at 37°C for approximately one week. At this time, fresh media is added and subsequently changed every several days. After an additional two weeks in culture, a monolayer of fibroblasts emerge. The monolayer is trypsinized and scaled into larger flasks.

pMV-7 (Kirschmeier, P.T. *et al*, *DNA*, 7:219-25 (1988)) flanked by the long terminal repeats of the Moloney murine sarcoma virus, is digested with EcoRI and HindIII and subsequently treated with calf intestinal phosphatase. The linear vector is fractionated on agarose gel and purified, using glass beads.

The cDNA encoding a polypeptide of the present invention is amplified using PCR primers which correspond to the 5' and 3' end sequences respectively. The 5' primer containing an EcoRI site and the 3' primer further includes a HindIII site. Equal quantities of the Moloney murine sarcoma virus linear backbone and the amplified EcoRI and HindIII fragment are added together, in the presence of T4 DNA ligase. The resulting mixture is maintained under conditions appropriate for ligation of the two fragments. The ligation mixture is used to transform bacteria HB101, which are then plated onto agar-containing kanamycin for the purpose of confirming that the vector had the gene of interest properly inserted.

The amphotropic pA317 or GP+aml2 packaging cells are grown in tissue culture to confluent density in Dulbecco's Modified Eagles Medium (DMEM) with 10% calf serum (CS), penicillin and streptomycin. The MSV vector containing the gene is then added to the media and the packaging cells are transduced with the vector. The packaging cells now produce infectious viral particles containing the gene (the packaging cells are now referred to as producer cells).

Fresh media is added to the transduced producer cells, and subsequently, the media is harvested from a 10 cm plate of confluent producer cells. The spent media, containing the infectious viral particles, is filtered through a millipore filter to remove detached producer cells and this media is then used to infect fibroblast cells. Media is removed from a sub-confluent plate of fibroblasts and

quickly replaced with the media from the producer cells. This media is removed and replaced with fresh media. If the titer of virus is high, then virtually all fibroblasts will be infected and no selection is required. If the titer is very low, then it is necessary to use a retroviral vector that has a selectable marker, such as neo or his.

The engineered fibroblasts are then injected into the host, either alone or after having been grown to confluence on cytodex 3 microcarrier beads. The fibroblasts now produce the protein product.

Example 7

Tissue distribution of KGF-2 mRNA expression

Northern blot analysis is carried out to examine the levels of expression of the gene encoding the KGF-2 protein in human tissues, using methods described by, among others, Sambrook *et al.*, cited above. A probe corresponding to the entire open reading frame of KGF-2 of the present invention (SEQ ID NO:1) was obtained by PCR and was labeled with ³²P using the *rediprime*TM DNA labeling system (Amersham Life Science), according to manufacturer's instructions. After labelling, the probe was purified using a CHROMA SPIN-100TM column (Clontech Laboratories, Inc.), according to manufacturer's protocol number PT1200-1. The purified labelled probe was then used to examine various human tissues for the expression of the gene encoding KGF-2.

Multiple Tissue Northern (MTN) blots containing poly A RNA from various human tissues (H) or human immune system tissues (IM) were obtained from Clontech and were examined with labelled probe using ExpressHybTM Hybridization Solution (Clontech) according to manufacturer's protocol number PT1190-1. Following hybridization and washing, the blots are mounted and exposed to film at -70°C overnight, and films developed according to standard procedures.

A major mRNA species of approximately 4.2 kb was observed in most

human tissues. The KGF-2 mRNA was relatively abundant in heart, pancreas, placenta and ovary. A minor mRNA species of about 5.2 kb was also observed ubiquitously. The identity of this 5.2 kb mRNA species was not clear. It is possible that the 5.2 kb transcript encodes an alternatively spliced form of KGF-2 or a third member of the KGF family. The KGF-2 cDNA was 4.1 kb, consistent with the size of the mRNA of 4.2 kb.

Example 8

Keratinocyte Proliferation Assays

Dermal keratinocytes are cells in the epidermis of the skin. The growth and spreading of keratinocytes in the skin is an important process in wound healing. A proliferation assay of keratinocyte is therefore a valuable indicator of protein activities in stimulating keratinocyte growth and consequently, wound healing.

Keratinocytes are, however, difficult to grow *in vitro*. Few keratinocyte cell lines exist. These cell lines have different cellular and genetic defects. In order to avoid complications of this assay by cellular defects such as loss of key growth factor receptors or dependence of key growth factors for growth, primary dermal keratinocytes are chosen for this assay. These primary keratinocytes are obtained from Clonetics, Inc. (San Diego, CA).

Keratinocyte proliferation assay with alamarBlue

alamarBlue is a viable blue dye that is metabolized by the mitochondria when added to the culture media. The dye then turns red in tissue culture supernatants. The amounts of the red dye may be directly quantitated by reading difference in optical densities between 570 nm and 600 nm. This reading reflects cellular activities and cell number.

Normal primary dermal keratinocytes (CC-0255, NHEK-Neo pooled) are purchased from Clonetics, Inc. These cells are passage 2. Keratinocytes are

grown in complete keratinocyte growth media (CC-3001, KGM; Clonetics, Inc.) until they reach 80% confluency. The cells are trypsinized according to the manufacturer's specification. Briefly, cells were washed twice with Hank's balanced salt solution. 2-3 ml of trypsin was added to cells for about 3-5 min at room temperature. Trypsin neutralization solution was added and cells were collected. Cells are spun at 600 xg for 5 min at room temperature and plated into new flasks at 3,000 cells per square centimeter using pre-warmed media.

For the proliferation assay, plate 1,000-2,000 keratinocytes per well of the Corning flat bottom 96-well plates in complete media except for the outermost rows. Fill the outer wells with 200 μ l of sterile water. This helps to keep temperature and moisture fluctuations of the wells to the minimum. Grow cells overnight at 37°C with 5% CO₂. Wash cells twice with keratinocyte basal media (CC-3101, KBM, Clonetics, Inc.) and add 100 μ l of KBM into each well. Incubate for 24 hours. Dilute growth factors in KBM in serial dilution and add 100 μ l to each well. Use KGM as a positive control and KBM as a negative control. Six wells are used for each concentration point. Incubate for two to three days. At the end of incubation, wash cells once with KBM and add 100 μ l of KBM with 10% v/v alamarBlue pre-mixed in the media. Incubate for 6 to 16 hours until media color starts to turn red in the KGM positive control. Measure O.D. 570 nm minus O.D. 600 nm by directly placing plates in the plate reader.

Results

Stimulation of Keratinocyte proliferation by KGF-2

To demonstrate that KGF-2 (Cys37-Ser208 with a 6X (His) tag (SEQ ID NOs: 29-30; Figure 5) and N-terminal deletion mutants KGF-2 Δ 33 and KGF-2 Δ 28 were active in stimulating epidermal keratinocyte growth, normal primary human epidermal keratinocytes were incubated with the E. coli-expressed and purified KGF-2 protein (batch number E3), KGF-2 Δ 33 (batch number E1) and KGF-2 Δ 28 (batch number E2). The KGF-2 protein stimulated the growth of epidermal keratinocytes with an EC50 of approximately 5 ng/ml, equivalent to that of FGF7/KGF-1 (Figure 6A). In contrast, other FGF's such as FGF-1 and

FGF-2 did not stimulate the growth of primary keratinocytes. The EC50 for KGF-2Δ33 was 0.2 ng/ml and that for KGF-2Δ28 2ng/ml (See Figures 6B and C). Thus, KGF-2 appeared to be as potent as FGF7/KGF in stimulating the proliferation of primary epidermal keratinocytes. However, KGF-2Δ33 is more potent in stimulating keratinocyte proliferation than the "Cys (37)" KGF-2 described above and the KGF-2Δ28.

Scarring of wound tissues involves hyperproliferation of dermal fibroblasts. To determine whether the stimulatory effects of KGF-2 was specific for keratinocytes but not for fibroblasts, mouse Balb.c.3T3 fibroblasts and human lung fibroblasts were tested. Neither types of fibroblasts responded to KGF-2 in proliferation assays. Therefore, KGF-2 appeared to be a mitogen specific for epidermal keratinocytes but not mesenchymal cells such as fibroblasts. This suggested that the likelihood of KGF-2 causing scarring of the wound tissues was low.

Example 9

A. Mitogenic Effects of KGF-2 on Cells Transfected with Specific FGF Receptors

To determine which FGF receptor isoform(s) mediate the proliferative effects of KGF-2, the effects of KGF-2 on cells expressing specific FGF receptor isoforms were tested according to the method described by Santos-Ocampo *et al. J. Biol. Chem.* 271:1726-1731 (1996). FGF7/KGF was known to induce mitogenesis of epithelial cells by binding to and specifically activating the FGFR2iiib form (Miki *et al. Science* 251:72-75 (1991)). Therefore, the proliferative effects of KGF-2 in mitogenesis assays were tested using cells expressing one of the following FGF receptor isoforms: FGFR1iiib, FGFR2iiib, FGFR3iiib, and FGFR4.

Mitogenesis assay of cells expressing FGF receptors

Thymidine incorporation of BaF3 cells expressing specific FGF receptors were performed as described by Santos-Ocampo *et al. J. Biol. Chem.* 271:1726-1731 (1996). Briefly, BaF3 cells expressing specific FGF receptors were washed and resuspended in Dubeco's modified Eagle's medium, 10% neonatal bovine serum, L-glutamine. Approximately 22,500 cells were plated per well in a 96-well assay plate in media containing 2 µg/ml Heparin. Test reagents were added to each well for a total volume of 200 µl per well. The cells were incubated for 2 days at 37°C. To each well, 1 µCi of ³H-thymidine was then added in a volume of 50 µl. Cells were harvested after 4-5 hours by filtration through glass fiber paper. Incorporated ³H-thymidine was counted on a Wallac beta plate scintillation counter.

Results

The results revealed that KGF-2 protein (Thr (36) - Ser (208) of Figure 1 (SEQ ID NO:2) with a N-terminal Met added thereto) strongly stimulated the proliferation of Baf3 cells expressing the KGF receptor, FGFR2iiib isoform, as indicated by ³H-thymidine incorporation (Figure 7A). Interestingly, a slight stimulatory effect of KGF-2 on the proliferation of Baf3 cells expressing the FGFR1iiib isoform was observed. KGF-2 did not have any effects on cells expressing the FGFR3iiib or the FGFR4 forms of the receptor.

FGF7/KGF stimulated the proliferation of cells expressing the KGF receptor, FGFR2iiib but not FGFR1iiib isoform. The difference between KGF-2 and FGF7/KGF was intriguing. In the control experiments, aFGF stimulated its receptors, FGFR1iiib and iiic and bFGF stimulated its receptor FGFR2iiic. Thus, these results suggested that KGF-2 binds to FGFR2iiib isoform and stimulates mitogenesis. In contrast to FGF7/KGF, KGF-2 also binds FGFR1iiib isoform and stimulates mitogenesis.

B. Mitogenic effects of KGF-2Δ33 on Cells Transfected with Specific FGF Receptors

As demonstrated above FGFs or KGF-1 and -2 both bind to and activate

the FGF 2iiiib receptor (FGFR 2iiiib). The proliferative effects of KGF-2Δ33 in mitogenesis assays were tested using cells expressing one of the following FGF receptor isoforms: FGFR2iiiib or FGFR2iiic (the 2iiic receptor-transfected cells are included as a negative control).

5 The experiments were performed as above in part A of this example. Briefly, BaF3 cells were grown in RPMI containing 10% bovine calf serum (BCS - not fetal serum), 10% conditioned medium from cultures of WEHI3 cells (grown in RPMI containing 5%BCS), 50nM β-mercaptoethanol, L-Glu (2% of a 100X stock) and pen/strep (1% of a 100X stock).

10 For the assay, BaF3 cells were rinsed twice in RPMI medium containing 10% BCS and 1 μg/ml heparin. BaF3 cells (22,000/well) were plated in a 96-well plate in 150 μl of RPMI medium containing 10% BCS and 1 μg/ml heparin. Acidic FGF, basic FGF, KGF-1 (HG15400) or KGF-2 proteins (HG03400, 03401, 03410 or 03411) were added at concentrations from approximately 0 to
15 10 nM. The cells were incubated in a final volume of 200μl for 48 hours at 37°C. All assays were done in triplicate. Tritiated thymidine (0.5 μCi) was added to each well for 4 hours at 37°C and the cells were then harvested by filtration through a glass fiber filter. The total amount of radioactivity incorporated was then determined by liquid scintillation counting. The following positive controls
20 were used: basic FGF and acidic FGF for FGFR2iiic cells; acidic FGF and KGF-1 for FGFR2iiiib cells. The following negative controls were used: Basal medium (RPMI medium containing 10% BCS and 1 μg/ml heparin).

Results

25 The results revealed that KGF-2 (Thr (36) - Ser (208) with N-terminal Met added), KGF-2Δ33 and KGF-2Δ28 proteins strongly stimulated the proliferation of BaF3 cells expressing the KGF receptor, FGFR2iiiib isoform, as indicated by ³H-thymidine incorporation (Figures 7A-C). The KGF-2 proteins did not have any effects on cells expressing the FGFR2iiic forms of the receptor. These results suggested that KGF-2 proteins bind to FGFR2iiiib isoform and
30 stimulates mitogenesis. In addition, it appears that KGF-2Δ33 was able to

stimulate the proliferation of the BaF3 cells better than the KGF-2 (Thr (36) - Ser (208)).

Example 10

A. Construction of E. coli Optimized Full Length KGF-2

5 In order to increase expression levels of full length KGF-2 in an E. coli expression system, the codons of the amino terminal portion of the gene were optimized to highly used E. coli codons. For the synthesis of the optimized region of KGF-2, a series of six oligonucleotides were synthesized: numbers 1-6 (sequences set forth below). These overlapping oligos were used in a PCR
10 reaction for seven rounds at the following conditions:

Denaturation	95 degrees	20 seconds
Annealing	58 degrees	20 seconds
Extension	72 degrees	60 seconds

A second PCR reaction was set up using 1 µl of the first PCR reaction
15 with KFG-2 synthetic primer 6 as the 3' primer and KGF-2 synthetic 5' BamHI as the 5' primer using the same conditions as described above for 25 cycles. The product produced by this final reaction was restricted with AvaII and BamHI. The KGF-2 construct of Example 1 was restricted with AvaII and HindIII and the fragment was isolated. These two fragments were cloned into pQE-9 restricted
20 with BamHI and HindIII in a three fragment ligation.

Primers used for constructing the optimized synthetic KGF-2 1/208:

KGF-2 Synthetic Primer 1:

ATGTGGAAATGGATACTGACCCACTGCGCTTCTGCTTTCCCGCACC
TGCCGGGTTGCTGCTGCTGCTGCTTCCTGCTGCTGTTC (SEQ ID NO: 31)

25 KGF-2 Synthetic Primer 2:

CCGGAGAAACCATGTCCTGACCCAGAGCCTGGCAGGTAACCGGAA
CAGAAGAAACCAGGAACAGCAGCAGGAAGCAGCAGCA (SEQ
ID NO: 32)

KGF-2 Synthetic Primer 3:

GGGTCAGGACATGGTTTCTCCGGAAGCTACCAACTCTTCTTCTTCTT
CTTCTCTTCTCCGTCTTCTGCTGGTCGTCACG (SEQ ID NO: 33)

KGF-2 Synthetic Primer 4:

5 GGTGAAAGAGAACAGTTTACGCCAACGAACGTCACCCTGCAGGTG
GTTGTAAGAACGAACGTGACGACCAGCAGAAGACGG (SEQ ID
NO:34)

KGF-2 Synthetic Primer 5:

10 CGTTGGCGTAAACTGTTCTCTTTCACCAAATACTTCCTGAAAATCGA
AAAAAACGGTAAAGTTTCTGGGACCAAA (SEQ ID NO:35)

KGF-2 Synthetic Primer 6:

TTTGGTCCCAGAACTTTACCGTTTTTTTCGATTTTCAG (SEQ ID
NO:36)

KGF-2 Synthetic 5' BamHI

15 AAAGGATCCATGTGGAAATGGATACTGACCCACTGC (SEQ ID NO:37)

The resulting clone is shown in Figure 10 (SEQ ID NOS: 38 and 39).

B. Construction of *E. coli* Optimized Mature KGF-2

20 In order to further increase expression levels of the mature form of KGF-2
in an *E. coli* expression system, the codons of the amino terminal portion of the
gene were optimized to highly used *E. coli* codons. To correspond with the
mature form of KGF-1, a truncated form of KGF-2 was constructed starting at
threonine 36. *E. coli* synthetic KGF-2 from Example 10 A was used as a template
in a PCR reaction using BspHI 5' KGF-2 as the 5' primer (sequence given below)
and HindIII 3' KGF-2 as the 3' primer (sequence given below). Amplification was
25 performed using standard conditions as given above in Example 10 A for 25
cycles. The resulting product was restricted with BspHI and HindII and cloned
into the *E. coli* expression vector pQE60 digested with NcoI and HindIII.

BspHI 5' KGF-2 Primer:

TTTCATGACTTGTCAAGCTCTGGGTCAAGATATGGTTC (SEQ ID NO:40)

HindIII 3' KGF-2 Primer:

GCCCAAGCTTCCACAAACGTTGCCTTCC (SEQ ID NO:41)

The resulting clone is shown in Figure 11A (SEQ ID NO:42 and 43).

5 C. *Construction of an Alternate E. coli Optimized Mature KGF-2*

In order to further increase expression levels of the mature form of KGF-2 in an E. coli expression system, the codons of 53 amino acids at the amino terminal portion of the E. coli optimized gene were changed to alternate highly used E. coli codons. For the synthesis of the optimized region of KGF-2, a series of six oligonucleotides were synthesized: numbers 18062, 18061, 18058, 18064, 18059, and 18063 (sequences set forth below). These overlapping oligos were used in a PCR reaction for seven rounds at the following conditions:

	Denaturation	95 degrees	20 seconds
	Annealing	58 degrees	20 seconds
15	Extension	72 degrees	60 seconds

Following the seven rounds of synthesis, a 5' primer to this region, 18169 and a 3' primer to this entire region, 18060, were added to a PCR reaction, containing 1 microliter from the initial reaction of the six oligonucleotides. This product was amplified for 30 rounds using the following conditions:

20	Denaturation	95 degrees	20 seconds
	Annealing	55 degrees	20 seconds
	Extension	72 degrees	60 seconds

A second PCR reaction was set up to amplify the 3' region of the gene using primers 18066 and 18065 under the same conditions as described above for 25 rounds. The resulting products were separated on an agarose gel. Gel slices containing the product were diluted in 10mM Tris, 1mM EDTA, pH 7.5. One microliter each from each of diluted gel slices were used in an additional PCR

reaction using primer 18169 as the 5' primer, and primer 18065 as the 3' primer. The product was amplified for 25 cycles using the same conditions as above. The product produced by this final reaction was and restricted with Eco R1 and HindIII, and cloned into pQE60, which was also cut with Eco R1 and HindIII (pQE6 now).

Sequences of the 5' Synthetic Primers:

18169 KGF2 5' EcoRI/RBS:

TCAGTGAATTCATTAAAGAGGAGAAATTAATCATGACTTGCCAGG
[SEQ ID NO:44]

18062 KGF2 synth new R1 sense:

TCATGACTTGCCAGGCACTGGGTCAAGACATGGTTTCCCCGGAAGCTA
[SEQ ID NO:45]

18061 KGF2 synth R2 sense:

GCTTCAGCAGCCCATCTAGCGCAGGTCGTCACGTTGCTCTTACAACC
[SEQ ID NO:46]

18058 KGF2 Synth R3 sense:

GTTCGTTGGCGCAAACCTGTTTCAGCTTTACCAAGTACTTCCTGAAAATC
[SEQ ID NO:47]

18066 KGF 2 20 bp Ava II sense:

TCGAAAAAACGGTAAAGTTTCTGGGAC [SEQ ID NO:48]

18064 KGF2 synth F1 antisense:

GATGGGCTGCTGAAGCTAGAGCTGGAGCTGTTGGTAGCTTCCGGGG
AA [SEQ ID NO:49]

18059 KGF2 Synth F2 antisense:

AACAGTTTGCGCCAACGAACATCACCTGTAAGTGGTTGTAAGAG
[SEQ ID NO:50]

18063 KGF2 Synth F3 antisense:

TTCTTGGTCCCAGAACTTTACCGTTTTTTTCGATTTTCAGGAAGTA
[SEQ ID NO:51]

18060 KGF 2 Ava II antisense:

-121-

TTCTTGGTCCCAGAACTTTACCG [SEQ ID NO:52]

18065 KGF2 HindIII 3' Stop:AGATCAGGCTTCTATTATTATGAGTGTACCACCATTGGAAGAAAG
[SEQ ID NO:53]

- 5 The sequence of the synthetic KGF-2 gene and it corresponding amino acid is shown in Figure 11B (SEQ ID NO: 54 and 55)

Example 11

Construction of KGF-2 Deletion Mutants

- 10 Deletion mutants were constructed from the 5' terminus and 3' terminus of KGF-2 gene using the optimized KGF-2 construct from Example 10 A as a template. The deletions were selected based on regions of the gene that might negatively affect expression in *E. coli*. For the 5' deletion the primers listed below were used as the 5' primer. These primers contain the indicated restriction site and an ATG to code for the initiator methionine. The KGF-2 (FGF-12) 208
- 15 amino acid 3' HindIII primer was used for the 3' primer. PCR amplification for 25 rounds was performed using standard conditions as set forth in Example 10. The products for the KGF-2 36aa/208aa deletion mutant were restricted BspHI for the 5' site and HindIII for the 3' site and cloned into the pQE60 which has been
- 20 digested with BspHI and HindIII. All other products were restricted with NcoI for the 5' restriction enzyme and HindIII for the 3' site, and cloned into the pQE60 which had been digested with NcoI and HindIII. For KGF-2 (FGF-12), 36aa/153aa and 128aa 3' HindIII was used as the 3' primer with FGF-12 36aa/208aa as the 5' primer. For FGF-12 62aa/153aa, 128aa 3' HindIII was used as the 3' primer with FGF-12 62aa/208aa as the 5' primer. The nomenclature of
- 25 the resulting clones indicates the first and last amino acid of the polypeptide that results from the deletion. For example, KGF-2 36aa/153aa indicates that the first amino acid of the deletion mutant is amino acid 36 and the last amino acid is amino acid 153 of KGF-2. Further, as indicated in Figures 12-20, each mutant

-122-

has N-terminal Met added thereto.

Sequences of the Deletion Primers:

FGF12 36aa/208aa:

5' BspHI GGACCCTCATGACCTGCCAGGCTCTGGGTCAGGAC [SEQ ID
5 NO:56]

FGF12 63aa/208aa:

5' NcoI GGACAGCCATGGCTGGTCGTCACGTTTCG [SEQ ID NO:57]

FGF12 77aa/208aa:

5' NcoI GGACAGCCATGGTTCGTTGGCGTAAACTG [SEQ ID NO:58]

10 FGF12 93aa/208aa:

5' NcoI GGACAGCCATGGAAAAAACGGTAAAGTTTC [SEQ ID NO:59]

FGF12 104aa/208aa:

5' NcoI GGACCCCCATGGAGAACTGCCCCGTAGAGC [SEQ ID NO:60]

FGF12 123aa/208aa:

15 5' NcoI GGACCCCCATGGTCAAAGCCATTAACAGCAAC [SEQ ID NO:61]

FGF12 138aa/208aa:

5' NcoI GGACCCCCATGGGGAAACTCTATGGCTCAAAAG [SEQ ID
NO:62]

FGF12 3' HindIII: (Used for all above deletion clones)

20 CTGCCCAAGCTTATTATGAGTGTACCACCATTGGAAG [SEQ ID NO:63]

FGF12 36aa/153aa:

5' BspHI (as above)

3' HindIII CTGCCCAAGCTTATTACTTCAGCTTACAGTCATTGT [SEQ ID
NO:64]

25 FGF12 63aa/153aa:

5' NcoI and 3' HindIII, as above

The sequences for the resulting deletion mutations are set forth in Figures
12-20. [SEQ ID NOS:65-82]

Example 12

Construction of Cysteine Mutants of KGF-2

Construction of C-37 mutation primers 5457 5' BspHI and 5258 173aa 3' HindIII were used to amplify the KGF-2 (FGF-12) template from Example 10 A. Primer 5457 5' BspHI changes cysteine 37 to a serine. Amplification was done using the standard conditions outlined above in Example 10 A for 25 cycles. The resulting product was restricted with BspHI and HindIII and cloned into E. coli expression vector pQE60, digested with BspHI and HindIII. (Figure 21) [SEQ ID NO:83]

For mutation of Cysteine 106 to serine, two PCR reactions were set up for oligonucleotide site directed mutagenesis of this cysteine. In one reaction, 5453 BspHI was used as the 5' primer, and 5455 was used as the 3' primer in the reaction. In a second reaction, 5456 was used as the 5' primer, and 5258 HindIII was used as the 3' primer. The reactions were amplified for 25 rounds under standard conditions as set forth in Example 10. One microliter from each of these PCR reactions was used as template in a subsequent reaction using, as a 5' primer, 5453 BspHI, and as a 3' primer, 5258 HindIII. Amplification for 25 rounds was performed using standard conditions as set forth in Example 10. The resulting product was restricted with BspHI and HindIII and cloned into the E. coli expression vector pQE60, which was restricted with NcoI and HindIII.

Two PCR reactions were required to make the C-37/C-106 mutant. Primers 5457 BspHI and 5455 were used to create the 5' region of the mutant containing cysteine 37 to serine substitution, and primer 5456 and 5258 HindIII were used to create the 3' region of the mutant containing cysteine 106 to serine substitution. In the second reaction, the 5457 BspHI primer was used as the 5' primer and the 5258 HindIII primer was used as the 3' primer to create the C-37/C-106 mutant using 1µl from each of the initial reactions together as the template. This PCR product was restricted with BspHI and HindIII, and cloned into pQE60 that had been restricted with NcoI and HindIII. The resulting clone

is shown in Figure 22 (SEQ ID NO:84)

Sequences of the Cysteine Mutant Primers:

5457 BspHI: GGACCCTCATGACCTCTCAGGCTCTGGGT (SEQ ID NO:85)

5456: AAGGAGAACTCTCCGTACAGC (SEQ ID NO: 86)

5 5455: GCTGTACGGTCTGTTCTCCTT (SEQ ID NO: 87)

5453 BspHI: GGACCCTCATGACCTGCCAGGCTCTGGGTCAGGAC (SEQ ID NO: 88)

5258 HindIII: CTGCCCCAAGCTTATTATGAGTGTACCACCATTTGGAAG (SEQ ID NO: 89)

10

Example 13

Production and Purification of KGF-2 (FGF-12)

The DNA sequence encoding the optimized mature protein described in Example 10 B (i.e., amino acids T36 through S208 of KGF-2) was cloned into plasmid pQE-9 (Qiagen). E. coli (M15/rep4; Qiagen) were grown to stationary phase overnight at 37°C in LB containing 100 µg/ml Ampicillin and 25 µg/ml Kanamycin. This culture was used to inoculate fresh LB media containing containing 100 µg/ml Ampicillin and 25 µg/ml Kanamycin at a dilution of 1:50. The cells were grown at 37°C to an O.D.₅₉₅ of 0.7, induced by the addition of isopropyl 1-thio-β-D-galactopyranoside (IPTG) to a final concentration of 1mM.

15 After 3-4 hours, the cells were harvested by centrifugation, and resuspended in a buffer containing 60mM NaPO₄ and 360mM NaCl at a ratio of 5 volumes of buffer: 1 volume of cell paste. After disruption in a Mautin Gaulin, the extract was adjusted to pH to 8.0 by the addition of NaOH and clarified by centrifugation.

20

The clarified soluble extract was applied to a Poros HS-50 column (2.0X10.0 cm; PerSeptive Biosystems, Inc.) and bound proteins step-eluted with 50mM NaPO₄ pH 8.0 containing 0.5M, 1.0M and 1.5M NaCl. The KGF-2 eluted in the 1.5M salt fraction which was then diluted five-fold with 50mM NaPO₄ pH

25

6.5 to a final salt concentration of 300mM. This KGF-2 containing fraction was then passed sequentially over a Poros HQ-20 column (2.0X7.0 cm; PerSeptive Biosystems, Inc.) and then bound to a Poros CM-20 column (2.0X9.0 cm; PerSeptive Biosystems, Inc.). KGF-2 (FGF-12)-containing fractions that eluted
5 at about 500mM to about 750 mM NaCl were pooled, diluted and re-applied to an CM-20 column to concentrate. Finally, the protein was separated on a gel filtration column (S-75; Pharmacia) in 40mM NaOAC pH6.5; 150mM NaCl (Batch E-5) Alternatively, the gel filtration column was run in Phosphate Buffered Saline (PBS, Batch E-4). KGF-2 containing fractions were pooled and
10 protein concentration determined by Bio-Rad Protein Assay. Proteins were judged to be >90% pure by SDS-PAGE. Finally, endotoxin levels determined by Limulus Amebocyte Lysate Assay (Cape Cod Associates) were found to be \leq 1Eu/mg. Proteins prepared in this way were able to bind heparin which is a hallmark of FGF family members.

15

Example 14

A. Construction of N-terminal deletion mutant KGF-2 Δ 33

To increase the level of expression of KGF2 in E.coli, and to enhance the solubility and stability properties of E.coli expressed KGF2, a deletion variant
20 KGF-2 Δ 33 (KGF-2 aa 69-208) (SEQ ID NO:96) which removes the first 68 amino acids of the pre-processed KGF2 was generated. The rationale for creating this deletion variant was based on the following observations. Firstly, mature KGF2 (KGF-2 aa 36-208) contains an uneven number (three) of cysteine residues which can lead to aggregation due to intra-molecular disulphide bridge formation.
25 The KGF Δ 33 deletion variant contains only two cysteine residues, which reduces the potential for intra-molecular disulphide bridge formation and subsequent aggregation. A decrease in aggregation should lead to an increase in the yield of active KGF2 protein. Secondly, the KGF Δ 33 deletion variant removes a poly-serine stretch which is not present in KGF-1 and does not appear to be

important for activity, but may hinder expression of the protein in E. coli. Thus, removal of the poly-serine stretch may increase expression levels of active KGF-2 protein. Thirdly, expression of KGF $\Delta 33$ in E.coli, results in natural cleavage of KGF-2 between residues 68 and 69. Thus, it is anticipated that KGF2 $\Delta 33$ will be processed efficiently and will be stable in E.coli.

Construction of KGF-2 $\Delta 33$ in pQE6

To permit Polymerase Chain Reaction directed amplification and sub-cloning of KGF2 $\Delta 33$ into the E.coli protein expression vector, pQE6, two oligonucleotide primers (5952 and 19138) complementary to the desired region of KGF2 were synthesized with the following base sequence.

Primer 5952: 5' GCGGCACATGTCTTACAACCACCTGCAGGGTG 3' (SEQ ID NO:91)

Primer 19138: 5' GGGCCCAAGCTTATGAGTGTACCACCAT 3' (SEQ ID NO:92)

In the case of the N-terminal primer (5952), an AflIII restriction site was incorporated, while in the case of the C-terminal primer (19138) a HindIII restriction site was incorporated. Primer 5952 also contains an ATG sequence adjacent and in frame with the KGF2 coding region to allow translation of the cloned fragment in E.coli, while primer 19138 contains two stop codons (preferentially utilized in E.coli) adjacent and in frame with the KGF2 coding region which ensures correct translational termination in E.coli.

The Polymerase Chain Reaction was performed using standard conditions well known to those skilled in the art and the nucleotide sequence for the mature KGF-2 (aa 36-208) (constructed in Example 10C) as template. The resulting amplicon was restriction digested with AflIII and HindIII and subcloned into NcoI/HindIII digested pQE6 protein expression vector.

Construction of KGF-2 Δ 33 in pHE1

To permit Polymerase Chain Reaction directed amplification and subcloning of KGF2 Δ 33 into the E.coli expression vector, pHE1, two oligonucleotide primers (6153 and 6150) corresponding to the desired region of KGF2 were synthesized with the following base sequence.

Primer 6153: 5' CCGGCGGATCCCATATGTCTTACAACCACCTGCAGG
3' (SEQ ID NO:93)

Primer 6150: 5' CCGGCGGTACCTTATTATGAGTGTACCACCATTGG 3'
(SEQ ID NO:94)

In the case of the N-terminal primer (6153), an NdeI restriction site was incorporated, while in the case of the C-terminal primer (6150) an Asp718 restriction site was incorporated. Primer 6153 also contains an ATG sequence adjacent and in frame with the KGF2 coding region to allow translation of the cloned fragment in E.coli, while primer 6150 contains two stop codons (preferentially utilized in E.coli) adjacent and in frame with the KGF2 coding region which ensures correct translational termination in E.coli.

The Polymerase Chain Reaction was performed using standard conditions well known to those skilled in the art and the nucleotide sequence for the mature KGF-2 (aa 36-208) (constructed in Example 10C) as template. The resulting amplicon was restriction digested with NdeI and Asp718 and subcloned into NdeI/Asp718 digested pHE1 protein expression vector.

Nucleotide sequence of KGF-2 Δ 33:

ATGTCTTACAACCACCTGCAGGGTGACGTTGCGTTGGCGTAAACTGT
TCTCTTTCACCAAATACTTCCTGAAAATCGAAAA
AAACGGTAAAGTTTCTGGGACCAAGAAGGAGAACTGCCCGTACAG
CATCCTGGAGATAACATCAGTAGAAATCGGAGTTG
TTGCCGTCAAAGCCATTAACAGCAACTATTACTTAGCCATGAACAA
GAAGGGGAAACTCTATGGCTCAAAGAATTAAAC

5 AATGACTGTAAGCTGAAGGAGAGGATAGAGGAAAATGGATACAAT
ACCTATGCATCATTTAACTGGCAGCATAATGGGAG
GCAAAATGTATGTGGCATTGAATGAAAAAGGAGCTCCAAGG
AGAGGACAGAAAACACGAAGGAAAAACACCTCTGCTCACTTTCTT
CCAATGGTGGTACACTCATAA (SEQ ID NO:95)

Amino Acid sequence of KGF-2 Δ 33:

MSYNHLQGDVRWRKLSFTKYFLKIEKNGKVSGTKKENCPYSILEITS
VEIGVVAVKAINSNYLAMNKKGKLYGSKEFN
NDCKLKERIEENGYNTYASFNWQHNGRQMYVALNGKGAPRRGQKTR
10 RKNTSAHFLPMVVHS (SEQ ID NO:96)

B. Construction of an Optimized KGF-2 Δ 33

15 In order to increase the expression levels of KGF2 Δ 33 in E.coli, the
codons of the complete gene were optimized to match those most highly used in
E.coli. As the template utilised to generate the KGF2 Δ 33 was codon optimized
within the N-terminal region, the C-terminal amino acids (84-208) required
optimization.

20 Firstly, amino acids 172-208 were codon optimized to generate
KGF2 Δ 33(s172-208). This was achieved by an overlapping PCR strategy.
Oligonucleotides PM07 and PM08 (corresponding to amino acids 172-208) were
combined and annealed together by heating them to 70°C and allowing them to
cool to 37°C. The annealed oligonucleotides were then utilized as template for
a standard PCR reaction which was directed by primers PM09 and PM10. In a
separate PCR reaction following standard conditions well known to those skilled
25 in the art and using KGF2 Δ 33 as template, oligonucleotides PM05 (which
overlaps with the PstI site within coding region of KGF2) and PM11 were used
to amplify the region of KGF2 corresponding to amino acids 84-172. In a third
PCR reaction, the product of the first PCR reaction (corresponding to codon
optimized amino acids 172-208) and the product of the second PCR reaction
(corresponding to codon non-optimized amino acids 84-172) were combined and

used as template for a standard PCR reaction directed by oligonucleotides PM05 and PM10. The resulting amplicon was digested with Pst1/HindIII and sub-cloned into Pst1/HindIII digested pQE6KGF2Δ33, effectively substituting the corresponding non codon optimized region, and creating pQE6KGF2Δ33(s172-208).

To complete the codon optimization of KGF2, a synthetic gene codon optimized for the region of KGF2 corresponding to amino acids 84-172 was generated utilising overlapping oligonucleotides. Firstly, four oligonucleotides (PM31, PM32, PM33 and PM 34) were combined and seven cycles of the following PCR was performed: 94°C, 30 secs; 46.5°C, 30 secs; and 72°C, 30 secs.

A second PCR reaction directed by primers PM35 and PM36 was then performed following standard procedures, utilizing 1 μl of the first PCR reaction as template. The resulting codon optimized gene fragment was then digested with Pst1/Sal1 and subcloned into Pst1/Sal1 digested pQE6KGF2Δ33(s172-208) to create a fully optimized KGF2 encoding gene, pQE6KGF2Δ33s.

To create an alternative E.coli protein expression vector, KGF2Δ33s was PCR amplified utilising primers PM102 and PM130 on pQE6KGF2Δ33s. The resulting amplicon was digested with NdeI and EcoRV and subcloned into the pHE1 expression vector which had been digested with NdeI and Asp718 (blunt ended) to create pHE1Δ33s.

Oligonucleotide Sequences used in construction of codon optimized KGF2 Δ33s:

PM05: CAACCACCTGCAGGGTGACG (SEQ ID NO:97)

PM07: AACGGTCGACAAATGTATGTGGCACTGAACGGTAAAGGTG
CTCCACGTCGTGGTCAGAAAACCCGTCGTAAAAACACC (SEQ ID
NO:98)

PM08:

GGGCCCAAGCTTAAGAGTGTACCACCATTTGGCAGAAAGTGAGCAG
AGGTGTTTTTACGACGGTTTTCTGACCACG (SEQ ID NO:99)

PM09: GCCACATACATTTGTCGACCGTT (SEQ ID NO:100)

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PM10: GGGCCCAAGCTTAAGAGTG (SEQ ID NO:101)

PM11: GCCACATACATTTGTCGACCGTT (SEQ ID NO:102)

PM31:

CTGCAGGGTGACGTTGCGTTGGCGTAAACTGTTCTCCTTCACCAAAT
5 ACTTCCTGAAAATCGAAAAAACGGTAAAGTTTC
TGGTACCAAG (SEQ ID NO:103)

PM32:

AGCTTTAACAGCAACAACACCGATTTCAACGGAGGTGATTTCAGG
ATGGAGTACGGGCAGTTTTCTTTCTTGGTACCAG
10 AAACCTTACC (SEQ ID NO:104)

PM33:

GGTGTGTTGCTGTAAAGCTATCAACTCCAACCTACTACCTGGCTAT
GAACAAGAAAGGTAAACTGTACGGTTCCAAAGA
ATTTAACAAC (SEQ ID NO:105)

15 PM34:

GTCGACCGTTGTGCTGCCAGTTGAAGGAAGCGTAGGTGTTGTAACC
GTTTTCTTCGATACGTTCTTTCAGTTTACAGTCG
TTGTTAAATTCTTTGGAACC (SEQ ID NO:106)

PM35: GCGGCGTCGACCGTTGTGCTGCCAG (SEQ ID NO:107)

20 PM36: GCGGCCTGCAGGGTGACGTTGTTGG (SEQ ID NO:108)

PM102: CCGGCGGATCCCATATGTCTTACAACCACCTGCAGG (SEQ ID
NO:109)

PM130: CGCGCGATATCTTATTAAGAGTGTACCACCATTG (SEQ ID
NO:110)

25 **Nucleotide sequence of KGF-2 Δ33(s172-208):**

ATGTCTTACAACCACCTGCAGGGTGACGTTGCGTTGGCGTAAACTGT
TCTCCTTCACCAAATACTTCCTGAAAATCGAAAA
AAACGGTAAAGTTTCTGGTACCAAGAAAGAAAAGTACCCGTAATCC
ATCCTGGAAATCACCTCCGTTGAAATCGGTGTTG

30 TTGCTGTAAAGCTATCAACTCCAACCTACTACCTGGCTATGAACAA

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GAAAGGTAACTGTACGGTTCCAAAGAATTTAAC
 AACGACTGTAACTGAAAGAACGTATCGAAGAAAACGGTTACAAC
 ACCTACGCTTCCTTCAACTGGCAGCACAAACGGTCG
 ACAAATGTATGTGGCACTGAACGGTAAAGGTGCTCCACGTCGTGGT
 5 CAGAAAACCCGTCGTAAAAACACCTCTGCTCACTTTCTGCC
 AATGGTGGTACACTCTTAA (SEQ ID NO:111)

Amino Acid Sequence of KGF-2 Δ 33(s172-208):

MSYNHLQGDVRWRKLFSTKYFLKIEKNGKVSGTKKENCYPYSILEITS
 VEIGVVAVKAINSNYLAMNKKGKLYGSKEFNNDCKLKERIEENGYN
 10 TYASFNWQHNGRQMYVALNGKGAPRRGQKTRRKNTSAHFLPMVVHS
 (SEQ ID NO:112)

C. Construction of N-terminal deletion mutant KGF-2 Δ 4

To increase the level of expression of KGF2 in E.coli and to enhance the stability and solubility properties of E.coli expressed KGF2, a deletion variant
 15 KGF2 Δ 4 (amino acids 39-208) which removes the first 38 amino acids of pre-processed KGF2 was constructed, including the cysteine at position 37. As the resulting KGF2 deletion molecule contains an even number of cysteines, problems due to aggregation caused by intra-molecular disulphide bridge formation should be reduced, resulting in an enhanced level of expression of
 20 active protein.

To permit Polymerase Chain Reaction directed amplification and sub-cloning of KGF2 Δ 4 into the E.coli protein expression vector, pQE6, two oligonucleotide primers (PM61 and 19138) were synthesized with the following base sequence.

25 PM61: CGCGGCCATGGCTCTGGGTCAGGACATG (SEQ ID NO:113)
 19138: GGGCCCAAGCTTATGAGTGTACCACCAT (SEQ ID NO:114)

In the case of the N-terminal primer (PM61), an NcoI restriction site was

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incorporated, while in the case of the C-terminal primer (19138) a HindIII restriction site was incorporated. PM61 also contains an ATG sequence adjacent and in frame with the KGF2 coding region to allow translation of the cloned fragment in E.coli, while 19138 contains a stop codon (preferentially utilized in E.coli) adjacent to and in frame with the KGF2 coding region which ensures correct translational termination in E.coli.

The Polymerase Chain Reaction was performed using standard conditions well known to those skilled in the art and the full length KGF2 (aa 36-208) as template (constructed in Example 10C). The resulting amplicon was restriction digested with NcoI and HindIII and subcloned into NcoI/HindIII digested pQE6 protein expression vector.

Nucleotide Sequence of KGF-2 $\Delta 4$:

ATGGCTCTGGGTCAAGATATGGTTTCTCCGGAAGCTACCAACTCTT
CCTCTTCCTCTTTCTCTTCCCCGTCTTCCGCTGG
TCGTACGTTTCGTTCTTACAACCACCTGCAGGGTGACGTTTCGTTGGC
GTAAACTGTTCTCTTTACCAAATACTTCCTGA
AAATCGAAAAAACGGTAAAGTTTCTGGGACCAAGAAGGAGAACT
GCCCCGTACAGCATCCTGGAGATAACATCAGTAGAA
ATCGGAGTTGTTGCCGTCAAAGCCATTAAACAGCAACTATTACTTAG
CCATGAACAAGAAGGGGAAACTCTATGGCTCAA
AGAATTTAACAATGACTGTAAGCTGAAGGAGAGGATAGAGGAAAA
TGGATACAATACCTATGCATCATTTAACTGGCAGC
ATAATGGGAGGCAAATGTATGTGGCATTGAATGGAAAAGGAGCTC
CAAGGAGAGGACAGAAAACACGAAGGAAAAACACC
TCTGCTCACTTTCTTCCAATGGTGGTACACTCATAA (SEQ ID NO:115)

Amino Acid Sequence of KGF-2 $\Delta 4$:

MALGQDMVSPEATNSSSSSFSSPSSAGRHVRSYNHLQGDVVRWKLFSF
TKYFLKIEKNGKVSGTKKENCYPYSILEITSVEIGVVAVKAINSNYYLAM

NKKGKLYGSKEFNNDCKLKERIEENGYNTYASFNWQHNGRQMYVAL
NGKGAPRRGQKTRRKNTSAHFLPMVVHS (SEQ ID NO:116)

Example 15

Construction of Carboxy Terminal Mutations in KGF-2

5 The carboxyl terminus of KGF-2 is highly charged. The density of these charged residues may affect the stability and consequently the solubility of the protein. To produce muteins that might stabilize the protein in solution a series of mutations were created in this region of the gene.

10 To create point mutants 194 R/E, 194 R/Q, 191 K/E, 191 K/Q, 188R/E, 188R/Q, the 5952 KGFΔ33 5' Afl III 5' primer was used with the indicated 3' primers, which contain the appropriate point mutations for KGF-2, in PCR reactions using standard conditions well known to those skilled in the art with KGF-2Δ33 as template. The resulting products were restricted with AflIII and Hind III and cloned into the E. coli expression vector, pQE60 restricted with NcoI and Hind III.

KGF-2Δ33,194 R/E Construction:

The following primers were used:

5952 KGF Δ 33 5' Afl III:

5' GCGGCACATGTCTTACAACCACCTGCAGGGTG 3' (SEQ ID NO:117)

20 KGF2 3'HindIII 194aa R to E:

5'CTGCCCAAGCTTTTATGAGTGTACCACCATTTGGAAGAAAGTGAGC
AGAGGTGTTTTTTTCTCGTGTCTTCTGTCC 3' (SEQ ID NO:118)

KGF-2Δ33,194 R/E Nucleotide sequence:

25 ATGTCTTACAACCACCTGCAGGGTGACGTTTCGTTGGCGTAAACTGT
TCTCTTTCACCAAATACTTCCTGAAAATCGAAAA
AAACGGTAAAGTTTCTGGGACCAAGAAGGAGAACTGCCCCGTACAG

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CATCCTGGAGATAACATCAGTAGAAATCGGAGTTG
TTGCCGTCAAAGCCATTAACAGCAACTATTACTTAGCCATGAACAA
GAAGGGGAAACTCTATGGCTCAAAAGAATTTAAC
AATGACTGTAAGCTGAAGGAGAGGATAGAGGAAAATGGATACAAT
5 ACCTATGCATCATTTAACTGGCAGCATAATGGGAG
GCAAAATGTATGTGGCATTGAATGGAAAAGGAGCTCCAAGGAGAGG
ACAGAAAACACGAGAAAAAACACCTCTGCTCACT
TTCTTCCAATGGTGGTACACTCATAG (SEQ ID NO:119)

KGF-2Δ33,194 R/E Amino acid sequence:

10 MSYNHLQGDVRWRKLFSTKYFLKIEKNGKVSGTKKENCYPYSILEITS
VEIGVVAVKAINSNYLAMNKKGKLYGSKEFNNDCKLKERIEENGYN
TYASFNWQHNGRQMYVALNGKGAPRRGQKTREKNTSAHFLPMVVHS
(SEQ ID NO:120)

KGF-2 Δ33,194 R/Q Construction:

15 The following primers were used:

5952 KGF Δ33 5' Afl III:

5' GCGGCACATGTCTTACAACCACCTGCAGGGTG 3' (SEQ ID NO:121)

KGF2 3' HindIII 194 aa R to Q:

5'CTGCCCAAGCTTTTATGAGTGTACCACCATTGGAAGAAAGTGAGC
20 AGAGGTGTTTTTCTGTCGTGTTTTCTGTCC 3' (SEQ ID NO:122)

KGF-2 Δ33,194 R/Q Nucleotide Sequence:

ATGTCTTACAACCACCTGCAGGGTGACGTTTCGTTGGCGTAAACTGT
TCTCTTTCACCAAATACTTCCTGAAAATCGAAAA
AAACGGTAAAGTTTCTGGGACCAAGAAGGAGAACTGCCCCGTACAG
25 CATCCTGGAGATAACATCAGTAGAAATCGGAGTTG
TTGCCGTCAAAGCCATTAACAGCAACTATTACTTAGCCATGAACAA
GAAGGGGAAACTCTATGGCTCAAAAGAATTTAAC
AATGACTGTAAGCTGAAGGAGAGGATAGAGGAAAATGGATACAAT
ACCTATGCATCATTTAACTGGCAGCATAATGGGAG

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GCAAATGTATGTGGCATTGAATGGAAAAGGAGCTCCAAGGAGAGG
ACAGAAAACACGACAGAAAAACACCTCTGCTCACT
TTCTTCCAATGGTGGTACACTCATAG (SEQ ID NO:123)

KGF-2 Δ33,194 R/Q Amino Acid Sequence:

5 MSYNHLQGDVRWRKLFSTKYFLKIEKNGKVSGTKKENCPYSILEITS
VEIGVVAVKAINSNYYLAMNKKGKLYGSKEFNNDCKLKERIEENGYN
TYASFNWQHNGRQMYVALNGKGAPRRGQKTRQKNTSAHFLPMVVS
(SEQ ID NO:124)

KGF-2Δ33,191 K/E Construction:

10 The following primers were used:

5952 KGF Δ 33 5' Afl III:

5' GCGGCACATGTCTTACAACCACCTGCAGGGTG 3' (SEQ ID NO:125)

KGF2 3' HindIII 191aa K to E

15 5'CTGCCCCAAGCTTTTATGAGTGTACCACCATGGAAGAAAGTGAGC
AGAGGTGTTTTTCCTTCGTGTTTCCTGTCCTCTCCTTGG 3' (SEQ ID
NO:126)

KGF-2Δ33,191 K/E Nucleotide Sequence:

ATGTCTTACAACCACCTGCAGGGTGACGTTTCGTTGGCGTAAACTGT
TCTCTTTCACCAAATACTTCCTGAAAATCGAAAA
20 AAACGGTAAAGTTTCTGGGACCAAGAAGGAGAACTGCCCCGTACAG
CATCCTGGAGATAACATCAGTAGAAATCGGAGTTG
TTGCCGTCAAAGCCATTAACAGCAACTATTACTTAGCCATGAACAA
GAAGGGGAAACTCTATGGCTCAAAAGAATTAAAC
AATGACTGTAAGCTGAAGGAGAGGATAGAGGAAAATGGATACAAT
25 ACCTATGCATCATTTAACTGGCAGCATAATGGGAG
GCAAATGTATGTGGCATTGAATGGAAAAGGAGCTCCAAGGAGAGG
ACAGGAAACACGAAGGAAAAACACCTCTGCTCACT
TTCTTCCAATGGTGGTACACTCATAG (SEQ ID NO:127)

KGF-2Δ33,191 K/E Amino Acid Sequence:

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MSYNHLQGDVRWRKLFSTKYFLKIEKNGKVS GTKKENCPYSILEITS
VEIGVVAVKAINS NYYLAMNKKGKLYGSKEFNNDCKLKERIEENGYN
TYASFNWQHNGRQMYVALNGKGAPRRGQETRRKNTSAHFLPMVVHS
(SEQ ID NO:128)

5 **KGF-2 Δ33, 191 K/Q Construction:**

The following primers were used:

5952 KGFA33 5' Afl III:

5' GCGGCACATGTCTTACAACCACCTGCAGGGTG 3' (SEQ ID NO:129)

KGF2 3' HindIII 191aa K to Q

10 5'CTGCCCAAGCTTTTATGAGTGTACCACCATTTGGAAGAAAGTGAGC
AGAGGTGTTTTCTCTCGTGTCTGCTGTCCTCTCCTTGG 3' (SEQ ID
NO:130)

KGF-2 Δ33, 191 K/Q Nucleotide Sequence:

ATGTCTTACAACCACCTGCAGGGTGACGTTTCGTTGGCGTAAACTGT
15 TCTCTTTCACCAAATACTTCCTGAAAATCGAAAA
AAACGGTAAAGTTTCTGGGACCAAGAAGGAGAACTGCCCCGTACAG
CATCCTGGAGATAACATCAGTAGAAATCGGAGTTG
TTGCCGTCAAAGCCATTAACAGCAACTATTACTTAGCCATGAACAA
GAAGGGGAAACTCTATGGCTCAAAGAATTAAAC
20 AATGACTGTAAGCTGAAGGAGAGGATAGAGGAAAATGGATACAAT
ACCTATGCATCATTTAACTGGCAGCATAATGGGAG
GCAAATGTATGTGGCATTGAATGGAAAAGGAGCTCCAAGGAGAGG
ACAGCAGACACGAAGGAAAAACACCTCTGCTCACT
TTCTTCCAATGGTGGTACACTCATAG (SEQ ID NO:131)

25 **KGF-2 Δ33, 191 K/Q Amino Acid Sequence:**

MSYNHLQGDVRWRKLFSTKYFLKIEKNGKVS GTKKENCPYSILEITS
VEIGVVAVKAINS NYYLAMNKKGKLYGSKEFNNDCKLKERIEENGYN
TYASFNWQHNGRQMYVALNGKGAPRRGQQTRRKNTSAHFLPMVVHS
(SEQ ID NO:132)

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KGF-2Δ33, 188R/E Construction:

The following primers were used:

5952 KGFΔ33 5' Afl III:

5' GCGGCACATGTCTTACAACCACCTGCAGGGTG 3' (SEQ ID NO:133)

5 KGF2 3' HindIII 188aa R to E:

5'CTGCCCAAGCTTTTATGAGTGTACCACCATTGGAAGAAAGTGAGC

AGAGGTGTTTTTCCTTCGTGTTTTCTGTCCTTCCCTTGGAGCTCCTTT

3' (SEQ ID NO:134)

KGF-2Δ33, 188R/E Nucleotide Sequence:

10 ATGTCTTACAACCACCTGCAGGGTGACGTTGCGTGGCGTAAACTGT
TCTCTTTCACCAAATACTTCCTGAAAATCGAAAA
AAACGGTAAAGTTTCTGGGACCAAGAAGGAGAACTGCCCCGTACAG
CATCCTGGAGATAACATCAGTAGAAATCGGAGTTG
TTGCCGTCAAAGCCATTAACAGCAACTATTACTTAGCCATGAACAA
15 GAAGGGGAAACTCTATGGCTCAAAGAATTAAAC
AATGACTGTAAGCTGAAGGAGAGGATAGAGGAAAATGGATACAAT
ACCTATGCATCATTTAACTGGCAGCATAATGGGAG
GCAAATGTATGTGGCATTGAATGGAAAAGGAGCTCCAAGGGAAGG
ACAGAAAACACGAAGGAAAAACACCTCTGCTCACT
20 TTCTTCCAATGGTGGTACACTCATAG (SEQ ID NO:135)

KGF-2Δ33, 188R/E Amino Acid Sequence:

MYNHLQGDVRWRKLFSTKYFLKIEKNGKVSGTKKENCYPYSILEITSV
EIGVVAVKAINSNYLAMNKKGKLYGSKEFNNDCKLKERIEENGYN
YASFNWQHNGRQMYVALNGKGAPREGQKTRRKNTSAHFLPMVVHS
25 (SEQ ID NO:136)

KGF-2Δ33, 188 R/Q Construction:

The following primers were used:

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5952 KGF Δ33 5' Afl III:

5' GCGGCACATGTCTTACAACCACCTGCAGGGTG 3' (SEQ ID NO:137)

KGF2 3' HindIII 188aa R to Q:

5'CTGCCCAAGCTTTTATGAGTGTACCACCATGGAAGAAAGTGAGC
5 AGAGGTGTTTTTCCTTCGTGTTTTCTGTCCCTGCCTTGGAGCTCCTTT
3' (SEQ ID NO:138)

KGF-2Δ33, 188 R/Q Nucleotide Sequence:

ATGTCTTACAACCACCTGCAGGGTGACGTTTCGTTGGCGTAAACTGT
TCTCTTTCACCAAATACTTCCTGAAAATCGAAAA
10 AAACGGTAAAGTTTCTGGGACCAAGAAGGAGAACTGCCCCGTACAG
CATCCTGGAGATAACATCAGTAGAAATCGGAGTTG
TTGCCGTCAAAGCCATTAACAGCAACTATTACTTAGCCATGAACAA
GAAGGGGAAACTCTATGGCTCAAAAGAATTTAAC
AATGACTGTAAGCTGAAGGAGAGGATAGAGGAAAATGGATACAAT
15 ACCTATGCATCATTTAACTGGCAGCATAATGGGAG
GCAAATGTATGTGGCATTGAATGGAAAAGGAGCTCCAAGGCAGGG
ACAGAAAACACGAAGGAAAAACACCTCTGCTCACT
TTCTCCAATGGTGGTACACTCATAG (SEQ ID NO:139)

KGF-2Δ33, 188 R/Q Amino Acid Sequence:

20 MSYNHLQGDVRWRKLFSFTKYFLKIEKNGKVSGTKKENCYPYSILEITS
VEIGVVAVKAINSNYYLAMNKKGKLYGSKEFNNDCKLKERIEENGYN
TYASFNWQHNGRQMYVALNGKGAPRQGQKTRRKNTSAHFLPMVVHS
(SEQ ID NO:140)

KGF-2 Δ33, 183K/E Construction:

25 For mutation 183K/E, two PCR reactions were set up for oligonucleotide site directed mutagenesis of this lysine. In one reaction, 5952 KGFΔ 33 5' AflIII was used as the 5' primer, and KGF2 183aa K to E antisense was used as the 3' primer in the reaction. In a second reaction, KGF2 5' 183aa K to E sense was

used as the 5' primer, and KGF2 3' HindIII TAA stop was used as the 3' primer. KGF-2 Δ 33 was used as template for these reactions. The reactions were amplified under standard conditions well known to those skilled in the art. One microliter from each of these PCR reactions was used as template in a subsequent
5 reaction using, as a 5' primer, 5453 BspHI, and as a 3' primer, 5258 HindIII. Amplification was performed using standard conditions well known to those skilled in the art. The resulting product was restricted with Afl III and HindIII and cloned into the E. coli expression vector pQE60, which was restricted with NcoI and HindIII.

10 The following primers were used:

5952 KGF Δ 33 5' Afl III:

5' GCGGCACATGTCTTACAACCACCTGCAGGGTG 3' (SEQ ID NO:141)

KGF2 5' 183aa K to E sense:

5' TTGAATGGAGAAGGAGCTCCA 3' (SEQ ID NO:142)

15 KGF2 183aa K to E antisense:

5' TGGAGCTCCTTCTCCATTCAA 3' (SEQ ID NO:143)

KGF2 3' HindIII TAA stop:

5' CTGCCCCAAGCTTTTATGAGTGTACCACCATTGG 3' (SEQ ID NO:144)

KGF-2 Δ 33, 183K/E Nucleotide Sequence:

20 ATGTCTTACAACCACCTGCAGGGTGACGTTGCGTGAACTGT
TCTCTTTCACCAAATACTTCCTGAAAATCGAAAA
AAACGGTAAAGTTTCTGGGACCAAGAAGGAGAACTGCCCCGTACAG
CATCCTGGAGATAACATCAGTAGAAATCGGAGTTG
TTGCCGTCAAAGCCATTAACAGCAACTATTACTTAGCCATGAACAA
25 GAAGGGGAACTCTATGGCTCAAAAGAATTTAAC
AATGACTGTAAGCTGAAGGAGAGGATAGAGGAAAATGGATACAAT
ACCTATGCATCATTTAACTGGCAGCATAATGGGAG
GCAAATGTATGTGGCATTGAATGGAGAAGGAGCTCCAAGGAGAGG
ACAGAAAACACGAAGGAAAAACACCTCTGCTCACT

TTCTTCCAATGGTGGTACACTCATAG (SEQ ID NO:145)

KGF-2 Δ 33, 183K/E Amino Acid Sequence:

MSYNHLQGDVRWRKLFSTKYFLKIEKNGKVSGTKKENCYPYSILEITS
VEIGVVAVKAINSNYLAMNKKGKLYGSKEFNNDCKLKERIEENGYN
5 TYASFNWQHNGRQMYVALNGEGAPRRGQKTRRKNTSAHFLPMVVHS
(SEQ ID NO:146)

Example 16

***Effects of KGF-2 Δ 33 on Normal Urinary Bladder and Prostate
and in Cyclophosphamide-Induced Hemorrhagic Cystitis in Rats***

10 This example demonstrates that KGF-2 Δ 33 is capable of stimulating
urinary bladder proliferation in normal rats and that there is a therapeutic effect
of KGF-2 Δ 33 in a rat model of cyclophosphamide-induced hemorrhagic cystitis.

 Some cytotoxic agents used clinically have side effects resulting in the
inhibition of the proliferation of the normal epithelium in the bladder, leading to
15 potentially life-threatening ulceration and breakdown in the epithelial lining of the
bladder. For example, cyclophosphamide causes hemorrhagic cystitis in some
patients, a complication which can be severe and in some cases fatal. Fibrosis of
the urinary bladder may also develop with or without cystitis. This injury is
thought to be caused by cyclophosphamide metabolites excreted in the urine.
20 Hematuria caused by cyclophosphamide usually is present for several days, but
may persist. In severe cases medical or surgical treatment is required. Instances
of severe hemorrhagic cystitis result in discontinued cyclophosphamide therapy.
In addition, urinary bladder malignancies generally occur within two years of
cyclophosphamide treatment and occurs in patients who previously had
25 hemorrhagic cystitis (CYTOXAN (cyclophosphamide) package insert).
Cyclophosphamide has toxic effects on the prostate and male reproductive
systems. Cyclophosphamide treatment can result in the development of sterility,
and result in some degree of testicular atrophy.

***Effects of KGF-2 Δ33 on Normal Bladder, Testes and Prostate
Experimental Design***

Male Sprague-Dawley rats (160-220 g), (n=4 to 6/treatment group) were used in these studies. KGF-2 Δ33 was administered at a dose of 5 mg/kg/day. Daily ip or sc injections of recombinant KGF-2 Δ33 or buffer (40 mM sodium acetate + 150 mM NaCl at pH 6.5) were administered for a period of 1-7 days and the rats were sacrificed the following day. To examine the reversibility of effects induced with KGF-2 Δ33, additional animals were injected ip daily for 7 days with KGF-2 Δ33 or buffer and sacrificed after a 7 day treatment-free period.

On the day of sacrifice, rats were injected ip with 100 mg/kg of BrdU. Two hours later the rats were overdosed with ether and selected organs removed. Samples of tissues were fixed in 10% neutral buffered formalin for 24 hours and paraffin embedded. To detect BrdU incorporation into replicating cells, five micron sections were subjected to immunohistochemical procedures using a mouse anti-BrdU monoclonal antibody and the ABC Elite detection system. The sections were lightly counterstained with hematoxylin.

Sections were read by blinded observers. The number of proliferating cells was counted in 10 random fields per animal at a 10x magnification for the prostate. To assess the effects of KGF-2 Δ33 in the bladder, cross-sections of these tissues were prepared and the number of proliferating and non-proliferating cells were counted in ten random fields at 20x magnification. The results are expressed as the percentage of labeled to unlabeled cells. Data are presented as mean + SEM. Statistical analyses (two-tailed unpaired t-test) were performed with the StatView Software Package and statistical significance is defined as p < 0.05.

Results

Bladder

Intraperitoneal injection of KGF-2 Δ33 induced proliferation of bladder epithelial cells over the 7 day study period (solid squares, Figure 23) but this did not influence the weight of the organ. Subcutaneous administration elicited a

small increase in proliferation but this failed to achieve statistical significance (solid circles, Figure 23).

Prostate and Testes

5 Both sc and ip administration of KGF-2 $\Delta 33$ induced significant proliferation of the prostate (Figure 24) but this normalized after two injections. Prolonged ip treatment with KGF-2 $\Delta 33$ did not increase the weight of the prostate or testes.

Effects of KGF-2 $\Delta 33$ on Cyclophosphamide-Induced Hemorrhagic Cystitis Experimental Design

10 Male Sprague Dawley rats (300-400g) (n=5/group) were injected i.v. via the tail vein with buffer placebo or KGF-2 $\Delta 33$ at concentrations of 1 or 5 mg/kg 24 hours prior to a 200 mg/kg i.p. injection of cyclophosphamide. On the final day, 48 hours after cyclophosphamide injection, rats were injected ip with 100 mg/kg of BrdU. Two hours later the rats were killed by CO₂ administration.
15 Fixation of the bladder was done by direct injection of 10% formalin into the lumen of the bladder and rinsing of the exterior of the bladder with formalin. After 5 minutes, the bladder and prostate were removed. The urinary bladder and prostate gland were paraffin embedded, cross-sectioned and stained with H&E and a mouse anti-BrdU monoclonal antibody. The extent of urothelial damage
20 was assessed using the following scoring system: Bladders were graded by two independent observers to describe the extent of the loss of urothelium. (Urothelial damage was scored as 0, 25%, 50%, 75% and 100% loss of the urothelium). In addition, the thickness of the bladder wall was measured at 10 random sites per section and expressed in μ m.

25 *Results*

Macroscopic Observations

In rats treated with placebo and cyclophosphamide, bladders were thick and rigid. Upon injection of 10% formalin, very little expansion of the bladders

was noted. However, in the groups pretreated with KGF-2 $\Delta 33$, a greater elasticity of the bladder was noted upon direct injection with formalin suggesting a lesser degree of fibrosis.

Microscopic Observations

5

Bladder

Figure 25 shows the results of KGF-2 $\Delta 33$ pretreatment on the extent of ulceration in the bladder. In normal rats treated with i.p. saline (saline control), the bladders appeared normal histologically and no ulceration of the urothelium was observed. Administration of 200 mg/kg i.p. of cyclophosphamide resulted in ulceration of the bladder epithelium that was between 25 and 50% of the total epithelial area (with a mean of 37%). Administration of KGF-2 $\Delta 33$ 24 hours prior to cyclophosphamide resulted in a significant reduction in the extent of ulceration (1 mg/kg 0.4% $p=0.0128$, and 5 mg/kg 5%, $p=0.0338\%$) when compared to placebo treated animals receiving cyclophosphamide.

15

Figure 26 shows the effects of KGF-2 $\Delta 33$ on the thickness of the urinary bladder wall which includes epithelium, smooth muscle layers and the serosal surface. In groups treated with buffer alone, the thickness of the bladder wall is approximately 40 μm . Treatment with cyclophosphamide results in a 5 fold increase in bladder wall thickness to 210 μm . KGF-2 $\Delta 33$ pretreatment of cyclophosphamide treated animals resulted in a significant inhibition of cyclophosphamide enlargement of the bladder wall (1 mg/kg 98.6 μm ($p=0.007$) and at 5 mg/kg 52.3 μm ($p<0.0001$)) when compared to the cyclophosphamide treatment alone.

20

Prostate Gland

25

In rats receiving buffer and cyclophosphamide, marked atrophy of the prostatic glands (acini) was observed accompanied by enlargement of interstitial spaces with remarkable edema when compared to normals. In addition, epithelial cells lining the prostatic glands were observed to be much shorter and less dense than in corresponding normal prostatic tissue. KGF-2 $\Delta 33$ pretreatment at both

1 mg/kg and 5 mg/kg displayed a normal histological appearance of the prostatic gland. No increase in the interstitial spaces or edema was observed, and the epithelial cells lining the prostatic glands were similar in size and density to normal prostatic tissue.

5 ***Conclusion***

The results demonstrate that KGF-2 specifically induces proliferation of bladder epithelial cells and the epithelial cells lining the prostatic glands. The results also demonstrate that KGF-2 specifically results in a significant reduction in the extent of ulceration in cyclophosphamide-induced hemorrhagic cystitis.

10 ***Example 17***

Effects of KGF-2 Δ 33 on Platelet Levels in Rats

This experiment demonstrates that KGF-2 Δ 33 increases platelet levels.

Experimental Design

Adult Sprague-Dawley rats were treated daily with a sc injection of buffer or doses of KGF-2 Δ 33 (as shown in the Table below) for a period of 4 weeks. One set of animals was sacrificed at this time. Another set was sacrificed after a 4 week recovery period. Blood samples were taken by orbital sinus puncture after an overnight fast and collected in tubes containing EDTA anticoagulant or 3.13% w/v aqueous trisodium citrate anticoagulant for hematology and coagulation assays, respectively. Blood chemistry was performed on samples taken into lithium heparin anticoagulant.

Results

As shown in the Table below, significant increases in platelet levels were demonstrated in both male and female rats at 0.3 mg/kg ($p < 0.05$), 1 mg/kg ($p < 0.01$), 3 mg/kg ($p < 0.01$), and 10 mg/kg ($p < 0.001$) KGF-2 Δ 33 treatment

relative to buffer controls. In most instances these effects were reversible after a 4-week recovery period.

Effect of KGF-2Δ33 on platelet levels in rats

Treatment	Sex	After 4 weeks of treatment	After 4 weeks of recovery
		Platelet ($10^3/\mu\text{l}$)	Platelet ($10^3/\mu\text{l}$)
Buffer	Male	1166 ± 116	1083 ± 69
0.3 mg/kg	Male	1277 ± 96*	1048 ± 116
1 mg/kg	Male	1364 ± 166**	1124 ± 101
3 mg/kg	Male	1327 ± 74**	1129 ± 57
10 mg/kg	Male	1465 ± 152***	1248 ± 62*
Buffer	Female	1125 ± 182	1078 ± 123
0.3 mg/kg	Female	1243 ± 145*	1091 ± 106
1 mg/kg	Female	1328 ± 135**	1084 ± 98
3 mg/kg	Female	1339 ± 116**	1151 ± 177
10 mg/kg	Female	1533 ± 157***	1233 ± 146

*p < 0.05, **p < 0.01, ***p < 0.001

Example 18

Effects of KGF-2 Δ33 on Plasma Fibrinogen in Rats

This experiment demonstrates that KGF-2Δ33 increases plasma fibrinogen levels.

Experimental Design

Adult Sprague-Dawley rats were treated daily with a sc injection of buffer or doses of KGF-2Δ33 (as shown in the Table below) for a period of 4 weeks. One set of animals was sacrificed at this time. Another set was sacrificed after a 4 week recovery period. Blood samples were taken by orbital sinus puncture after an overnight fast and collected in tubes containing EDTA anticoagulant or 3.13% w/v aqueous trisodium citrate anticoagulant for hematology and coagulation assays, respectively. Blood chemistry was performed on samples taken into lithium heparin anticoagulant.

Results

As shown in the Table below, significant increases in plasma fibrinogen levels were demonstrated in male rats at 3 mg/kg ($p < 0.001$) and 10 mg/kg ($p < 0.001$) KGF-2Δ33 treatment relative to buffer controls, and in female rats at 1 mg/kg ($p < 0.001$), 3 mg/kg ($p < 0.001$), and 10 mg/kg ($p < 0.001$) KGF-2Δ33 treatment relative to buffer controls. In most instances these effects were reversible after a 4-week recovery period.

Effect of KGF-2Δ33 on Plasma Fibrinogen Levels in Rats

Treatment	Sex	After 4 weeks of treatment	After 4 weeks of recovery
		Fibrinogen (mg/dl)	Fibrinogen (mg/dl)
Buffer	Male	248 ± 24	214 ± 14
0.3 mg/kg	Male	252 ± 23	202 ± 14
1 mg/kg	Male	287 ± 49*	219 ± 10
3 mg/kg	Male	315 ± 24***	220 ± 10
10 mg/kg	Male	378 ± 46***	222 ± 21

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Treatment	Sex	After 4 weeks of treatment	After 4 weeks of recovery
Buffer	Female	194 ± 24	171 ± 25
0.3 mg/kg	Female	215 ± 29	195 ± 24
1 mg/kg	Female	248 ± 19***	191 ± 14
3 mg/kg	Female	248 ± 23***	175 ± 15
10 mg/kg	Female	303 ± 44***	182 ± 19

*p < 0.05, **p < 0.01, ***p < 0.001

Example 19

Effects of KGF-2 Δ33 on Total Serum Protein Levels in Rats

This experiment demonstrates that KGF-2Δ33 increases total serum protein levels.

Experimental Design

Adult Sprague-Dawley rats were treated daily with a sc injection of buffer or doses of KGF-2Δ33 (as shown in the Table below) for a period of 4 weeks. One set of animals was sacrificed at this time. Another set was sacrificed after a 4 week recovery period. Blood samples were taken by orbital sinus puncture after an overnight fast and collected in tubes containing EDTA anticoagulant or 3.13% w/v aqueous trisodium citrate anticoagulant for hematology and coagulation assays, respectively. Blood chemistry was performed on samples taken into lithium heparin anticoagulant.

Results

As shown in the Table below, significant increases in total serum protein levels were demonstrated in male and female rats at 1 mg/kg (p<0.001), 3 mg/kg

($p < 0.001$), and 10 mg/kg ($p < 0.001$) KGF-2 Δ 33 treatment relative to buffer controls. In some instances these effects were reversible after a 4-week recovery period.

Effect of KGF-2 Δ 33 on Total Serum Protein Levels in Rats

Treatment	Sex	After 4 weeks of treatment	After 4 weeks of recovery
		Total Protein (g/dl)	Total Protein (g/dl)
Buffer	Male	5.9 ± 0.3	6.4 ± 0.5
0.3 mg/kg	Male	6.1 ± 0.3	6.2 ± 0.3
1 mg/kg	Male	$6.6 \pm 0.2^{***}$	6.5 ± 0.2
3 mg/kg	Male	$6.7 \pm 0.4^{***}$	6.3 ± 0.2
10 mg/kg	Male	$6.9 \pm 0.4^{***}$	6.1 ± 0.0
Buffer	Female	5.9 ± 0.3	6.7 ± 0.2
0.3 mg/kg	Female	6.1 ± 0.2	6.6 ± 0.1
1 mg/kg	Female	$6.6 \pm 0.2^{***}$	6.5 ± 0.3
3 mg/kg	Female	$6.9 \pm 0.3^{***}$	6.5 ± 0.2
10 mg/kg	Female	$7.0 \pm 0.4^{***}$	$6.3 \pm 0.3^*$

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Example 20

Effects of KGF-2 Δ 33 on Serum Albumin Levels in Rats

This experiment demonstrates that KGF-2 Δ 33 increases serum albumin levels.

Experimental Design

Adult Sprague-Dawley rats were treated daily with a sc injection of buffer or doses of KGF-2Δ33 (as shown in the Table below) for a period of 4 weeks. One set of animals was sacrificed at this time. Another set was sacrificed after a 4 week recovery period. Blood samples were taken by orbital sinus puncture after an overnight fast and collected in tubes containing EDTA anticoagulant or 3.13% w/v aqueous trisodium citrate anticoagulant for hematology and coagulation assays, respectively. Blood chemistry was performed on samples taken into lithium heparin anticoagulant.

Results

As shown in the Table below, significant increases in serum albumin levels were demonstrated in male rats at 1 mg/kg ($p < 0.01$), 3 mg/kg ($p < 0.001$), and 10 mg/kg ($p < 0.001$) KGF-2Δ33 treatment relative to buffer controls, and in female rats at 1 mg/kg ($p < 0.001$), 3 mg/kg ($p < 0.001$), and 10 mg/kg ($p < 0.001$) KGF-2Δ33 treatment relative to buffer controls. In most instances these effects were reversible after a 4-week recovery period.

Effect of KGF-2Δ33 on Serum Albumin Levels in Rats

Treatment	Sex	After 4 weeks of treatment	After 4 weeks of recovery
		Albumin (g/dl)	Albumin (g/dl)
Buffer	Male	3.4 ± 0.2	3.4 ± 0.2
0.3 mg/kg	Male	3.5 ± 0.1	3.4 ± 0.1
1 mg/kg	Male	$3.6 \pm 0.1^{**}$	3.5 ± 0.0
3 mg/kg	Male	$3.7 \pm 0.2^{***}$	3.4 ± 0.2
10 mg/kg	Male	$3.7 \pm 0.2^{***}$	3.3 ± 0.1

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Treatment	Sex	After 4 weeks of treatment	After 4 weeks of recovery
Buffer	Female	3.4 ± 0.2	3.8 ± 0.1
0.3 mg/kg	Female	3.4 ± 0.2	3.7 ± 0.1
1 mg/kg	Female	3.7 ± 0.1***	3.6 ± 0.1*
3 mg/kg	Female	3.9 ± 0.2***	3.5 ± 0.1**
10 mg/kg	Female	3.9 ± 0.2***	3.5 ± 0.2**

*p < 0.05, **p < 0.01, ***p < 0.001

Example 21

Effects of KGF-2 Δ33 on Serum Globulin Levels in Rats

This experiment demonstrates that KGF-2Δ33 increases serum globulin levels.

Experimental Design

Adult Sprague-Dawley rats were treated daily with a sc injection of buffer or doses of KGF-2Δ33 (as shown in the Table below) for a period of 4 weeks. One set of animals was sacrificed at this time. Another set was sacrificed after a 4 week recovery period. Blood samples were taken by orbital sinus puncture after an overnight fast and collected in tubes containing EDTA anticoagulant or 3.13% w/v aqueous trisodium citrate anticoagulant for hematology and coagulation assays, respectively. Blood chemistry was performed on samples taken into lithium heparin anticoagulant.

Results

As shown in the Table below, significant increases in serum globulin levels were demonstrated in male and female rats at 1 mg/kg (p<0.001), 3 mg/kg

($p < 0.001$), and 10 mg/kg ($p < 0.001$) KGF-2Δ33 treatment relative to buffer controls. In some instances these effects were reversible after a 4-week recovery period.

Effect of KGF-2Δ33 on Serum Globulin Levels in Rats

Treatment	Sex	After 4 weeks of treatment	After 4 weeks of recovery
		Globulin (g/dl)	Globulin (g/dl)
Buffer	Male	2.5 ± 0.2	3.0 ± 0.3
0.3 mg/kg	Male	2.6 ± 0.2	2.8 ± 0.2
1 mg/kg	Male	$2.9 \pm 0.1^{***}$	3.1 ± 0.2
3 mg/kg	Male	$3.0 \pm 0.2^{***}$	2.9 ± 0.1
10 mg/kg	Male	$3.2 \pm 0.2^{***}$	2.8 ± 0.1
Buffer	Female	2.5 ± 0.1	2.9 ± 0.1
0.3 mg/kg	Female	2.7 ± 0.1	2.9 ± 0.1
1 mg/kg	Female	$2.9 \pm 0.1^{***}$	2.9 ± 0.2
3 mg/kg	Female	$3.0 \pm 0.2^{***}$	3.0 ± 0.2
10 mg/kg	Female	$3.1 \pm 0.3^{***}$	2.8 ± 0.2

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Example 22

Effect of KGF-2 on the Proliferation of Cells in Normal Rats

Introduction

KGF-2, a member of the FGF family, induces proliferation of normal human and rat keratinocytes. It has approximately 57% homology to KGF-1 (a

member of the FGF family). KGF-1 has been reported to induce proliferation of epithelia of many organs (Housley *et al.*, Keratinocyte growth factor induces proliferation of hepatocytes and epithelial cells throughout the rat gastrointestinal tract. *J Clin Invest* 94: 1764-1777 (1994); Ulich *et al.*, Keratinocyte growth factor is a growth factor for type II pneumocytes in vivo. *J Clin Invest* 93: 1298-1306 (1994); Ulich *et al.*, Keratinocyte growth factor is a growth factor for mammary epithelium *in vivo*. The mammary epithelium of lactating rats is resistant to the proliferative action of keratinocyte growth factor. *Am J Pathol* 144:862-868 (1994); Nguyen *et al.*, Expression of keratinocyte growth factor in embryonic liver of transgenic mice causes changes in epithelial growth and differentiation resulting in polycystic kidneys and other organ malformations. *Oncogene* 12:2109-2119 (1996); Yi *et al.*, Keratinocyte growth factor induces pancreatic ductal epithelial proliferation. *Am J Pathol* 145:80-85 (1994); and Yi *et al.*, Keratinocyte growth factor causes proliferation of urothelium in vivo. *J Urology* 154:1566-1570 (1995)). We performed similar experiments with KGF-2 to determine if it induces proliferation of normal epithelia in rats when administered systemically using sc and ip routes.

Methods

Male Sprague-Dawley rats, weighing 160-220 g, were obtained from Harlan Sprague Dawley for these studies. KGF-2 $\Delta 33$ (HG03411-E2) was administered at a dose of 5 mg/kg/day. Daily ip or sc injections of KGF-2 $\Delta 33$ or recombinant buffer (40 mM sodium acetate + 150 mM NaCl at pH 6.5) were administered for a period of 1-7 days and the rats were sacrificed the following day (see below). To examine the reversibility of effects induced with KGF-2 $\Delta 33$, additional animals were injected ip daily for 7 days with KGF-2 $\Delta 33$ or buffer and sacrificed after a 7 day treatment-free period.

On the day of sacrifice, rats were injected ip with 100 mg/kg of BrdU. Two hours later the rats were overdosed with ether and selected organs removed. In some studies organ weights were recorded. Samples of tissues were fixed in 10% neutral buffered formalin for 24 hours and paraffin embedded. To detect

BrdU incorporation into replicating cells, five micron sections were subjected to immunohistochemical procedures using a mouse anti-BrdU monoclonal antibody (Boehringer Mannheim) and the ABC Elite detection system (Vector Laboratories). The sections were lightly counterstained with hematoxylin.

5 Sections were read by blinded observers. The number of proliferating cells was counted in 10 random fields per animal at a 10x magnification for the following tissues: liver, pancreas, prostate, and heart. Ten random fields were used also for the lung analysis except the proliferation was quantitated at 20x magnification. Since the kidney has many functionally discrete areas, the
10 proliferation was assessed in a coronal cross-section taken through the center of one kidney per animal. To assess the effects of KGF-2 $\Delta 33$ in the esophagus and bladder, cross-sections of these tissues were prepared and the number of proliferating and non-proliferating cells were counted in ten random fields at a 10x and 20x magnification, respectively. The results are expressed as the
15 percentage of labeled to unlabeled cells.

 Data are presented as mean \pm SEM. Statistical analyses (two-tailed unpaired t-test) were performed with the StatView Software Package (Abacus Concepts, Inc., Berkeley, CA) and statistical significance is defined as $p < 0.05$.

Results

20 Figure 27 shows an overview of the experimental protocol. Six animals were used per group. However, during the analysis by the blinded observers it became clear that occasionally the BrdU injection was unsuccessful. Before the results were uncoded, the data from 8 rats out of 116 rats (or 7% of the animals) were excluded from the study and the resultant group sizes are shown in the Table
25 below.

Group sizes used in these studies

		n =		
	<u>Treatment</u>	<u>Time</u>	<u>ip</u>	<u>sc</u>
5	KGF-2 Δ33	1 day	6	5
	buffer	1 day	6	6
	KGF-2 Δ33	2 days	6	4
	buffer	2 days	6	6
	KGF-2 Δ33	3 days	5	5
	buffer	3 days	5	5
10	KGF-2 Δ33	7 days	6	6
	buffer	7 days	6	5
	KGF-2 Δ33	7 days + 7 days treatment-free	6	ND
	buffer	7 days + 7 days treatment-free	6	ND

Liver

When administered ip, KGF-2 Δ 33 induced a rapid proliferation of hepatocytes (solid squares) (Figure 28) after 1 injection and this augmented mitotic activity persisted for three days, returning to normal after 7 days of daily injections. In contrast to the dramatic effect ip administration of KGF-2 exerted on the liver, when given sc (solid circle, Figure 28) this growth factor demonstrated minor effects. Proliferation was elevated after one day of treatment but returned to normal values after two daily injections.

Pancreas

In contrast to the quickly reversible effects of ip administered KGF-2 Δ 33 on the liver, such injections induced proliferation of the pancreas which continued over the 14 day study period (solid squares, Figure 29). Surprisingly, subcutaneous administration of KGF-2 Δ 33 (solid circles) failed to induce proliferation at any time point.

Kidney and Bladder

5 KGF-2 $\Delta 33$ induced proliferation of renal epithelia when given either by the sc or ip route but the former induced a greater effect. SC administration induced a rapid increase in proliferation (solid circles) that peaked after 2 days which then returned to normal after 7 daily treatments (Figure 30). When KGF-2 $\Delta 33$ was given ip (solid squares, Figure 30), there was a modest, but significant increase in proliferation seen at days 2 and 3 only. Intraperitoneal injection of KGF-2 $\Delta 33$ also induced proliferation of bladder epithelial cells over the 7 day study period (solid squares, Figure 23). Subcutaneous administration elicited a small increase in proliferation but this failed to achieve statistical significance (solid circles, Figure 23).

Prostate

Both sc and ip administration of KGF-2 $\Delta 33$ induced significant proliferation of the prostate (Figure 24) but this normalized after two injections.

Esophagus

15 KGF-2 $\Delta 33$ given sc or ip elicited an early, short-lived increase in the proliferation of the esophageal cells (1 and 2 days, respectively) that rapidly returned to normal (results not shown).

Other organs

20 Systemic administration of KGF-2 $\Delta 33$ by the ip and sc routes failed to elicit proliferation of the lung epithelia over a 7 day dosing period (results not shown).

Discussion

25 When administered in a sc route, stimulation of normal epithelial proliferation in some organs (liver, kidney, esophagus. and prostate) were observed but these effects, for the most part, were short-lived and all were

reversible. The proliferation in these organs reversed even during daily sc administration of KGF-2.

5 The route of administration had dramatic effects on the observed proliferation. While daily ip administration increased the rate of liver proliferation over a 3 day period, animals given KGF-2 sc daily exhibited elevated rates after one day of treatment only. Even more surprising was the response of the pancreas. When animals were given KGF-2 ip, the pancreas exhibited a significantly elevated level of proliferation over the 14 day study period. However, sc administration of KGF-2 induced no increased mitotic activity in the pancreas. Likewise, ip, but not sc, treatment with KGF-2 elicited proliferation of the bladder mucosa.

10 IP administration of KGF-2 elicited a short-lived, small burst of proliferation in the kidney that was centered in the region containing collecting ducts. Daily sc treatment induced a prolonged, exaggerated proliferation in this area.

Example 23

Effects of KGF-2 $\Delta 33$ on Lung Cellular Proliferation Following Intratracheal Administration

20 This example demonstrates that KGF-2 $\Delta 33$ is capable of stimulating lung proliferation in normal rats following intratracheal administration (administration of KGF-2 $\Delta 33$ directly to the lung).

Methods

25 Male Lewis rats (220-270 g), (n=5/treatment group) were used in these studies. KGF-2 $\Delta 33$ or placebo (40 mM sodium acetate + 150 mM NaCl at pH 6.5) was administered intratracheally at doses of 1 and 5 mg/kg in a volume of 0.6 mls followed by 3 mls of air. Treatments were administered on day 1 and day 2 of the experimental protocol.

30 On day 3, the day of sacrifice, rats were injected ip with 100 mg/kg of BrdU. Two hours later the rats were killed by CO₂ asphyxiation. Lungs were

inflated with 10% buffered formalin via intratracheal catheter, and sagittal sections of lung were paraffin embedded. To detect BrdU incorporation into replicating cells, five micron sections were subjected to immunohistochemical procedures using a mouse anti-BrdU monoclonal antibody and the ABC Elite detection system. The sections were lightly counterstained with hematoxylin.

Sections were read by two blinded observers. The number of proliferating cells was counted in 10 random fields per section at a 20 x magnification. The results are expressed as the number of BrdU positive cells per field. Data are presented as mean \pm SEM. Statistical analyses (unpaired t-test) were performed with the Instat v2.0.1 and statistical significance is defined as $p < 0.05$.

Results

Intratracheal injection of KGF-2 $\Delta 33$ at 1 and 5 mg/kg resulted in an increase in proliferation of lung epithelial cells as shown in Figure 31. KGF-2 $\Delta 33$ treatment resulted in statistically significant increases in the number of BrdU positive cells/field at 1 mg/kg 23.4 cells/field ($p=0.0002$) and at 5 mg/kg 10.3 cells/field ($p=0.0003$) relative to buffer controls of 1.58 cells per field.

Example 24

KGF-2 Induces Proliferation of Normal Rat Salivary and Lacrimal Glands

Recombinant human KGF-2, a new member of the fibroblast growth factor (FGF) family was produced and purified. KGF-2 (FGF-10) has been shown to induce proliferation of mouse keratinocytes and rat prostate epithelial cells *in vitro* (Igarashi, M., *et al.*, *J. Biol. Chem.* 273:13230-13235 (1998); Emoto, H., *et al.*, *J. Biol. Chem.* 272:23191-23194 (1997); and Lu, W., *et al.*, *FASEB Journal* 12:A1463 (1998)). The effects of KGF-2 on the proliferative rate of salivary and lacrimal glands in normal rats were studied in this example. The lacrimal glands and two major salivary glands (parotid and submandibular) of normal rats that had been treated for 1-7 days with KGF-2 were examined and, as shown below, were found to have increased cellular proliferation.

Materials and Methods:**Recombinant KGF-2**

5 A bacterial expression vector (pHE4) encoding recombinant human KGF-2 was used to produce and purify KGF-2 Δ 33 from an E. coli expression system as previously described. The purified protein was ≥ 95 % pure as determined by SDS-PAGE and reverse-phase high performance liquid chromatography and had low endotoxin levels (≤ 0.5 EU/mg and ≤ 5 EU/ml).

Experimental Design

10 Male Sprague-Dawley rats were obtained from Harlan Sprague Dawley, Inc, Indianapolis, IN and weighed 166-243 g when used in these studies. The animals were maintained according to recommended standards (10) in microisolator cages with recycled paper bedding (Harlan Sprague Dawley, Inc) and provided with pelleted rodent diet (Harlan Sprague Dawley, Inc) and bottled drinking water on an ad libitum basis. The animal protocols used in this study
15 were reviewed and approved by the Human Genome Sciences Institutional Animal Care and Use Committee.

Animals were used in groups of 6 and were injected with KGF-2 Δ 33 (formulated in 40 mM sodium acetate and 150 mM sodium chloride at pH 6.5) at a dose of 5 mg/kg or with buffer (40 mM sodium acetate and 150 mM sodium
20 chloride at pH 6.5). Systemic treatments were administered by the intravenous route daily for a period of 1-7 days and rats were sacrificed 24 hours after the last treatment. To examine the reversibility of effects induced with KGF-2 Δ 33, additional animals were injected daily for 7 days with KGF-2 Δ 33 or buffer and sacrificed after a 7 day treatment-free period.

25 Histology

Two hours before sacrifice the rats were injected ip with 100 mg/kg of BrdU (Boehringer Mannheim Corp, Indianapolis, IN). The salivary glands were isolated, weighed, and fixed in 10% neutral buffered formalin for 24 hours. The eyes were removed intact and fixed. After fixation the tissues were paraffin

embedded. To detect BrdU incorporation into replicating cells, five micron sections were subjected to immunohistochemical procedures using a mouse anti-BrdU monoclonal antibody (Boehringer Mannheim Corp) and the ABC Elite detection system (Vector Laboratories, Inc, Burlingame, CA). The sections were
5 lightly counterstained with hematoxylin. Additional paraffin sections were stained with hematoxylin and eosin (H&E).

All sections used for quantitation were read by blinded observers. Three areas were randomly selected at a 10x magnification and the percent of positive cells per region of interest (% ROI) was assessed with the IPLab Spectrum
10 software (version 3.1.1) from Signal Analytics Corp., Vienna, VA.

Statistical analysis

Data are presented as mean \pm SEM. Statistical analyses were performed with the StatView Software Package (Abacus Concepts, Inc., Berkeley, CA). A factorial ANOVA with post hoc comparisons of Scheffe was used.

15 *Results*

After 5 to 6 daily intravenous injections with KGF-2 Δ 33 at a dose of 5 mg/kg, some of the rats had a wet muzzle. The effects of KGF-2 Δ 33 on the proliferation rate of the parotid and submandibular salivary glands were observed. Because both the salivary and lacrimal glands contain similar cells, and damage
20 to both glands occurs in clinical settings, the lacrimal gland was examined as well.

Parotid gland

KGF-2 Δ 33 at a dose of 5 mg/kg significantly increased proliferation of the serous secretory acini in the parotid gland after one injection. Quantitative
25 analysis also showed significant proliferation. As can be seen in Figure 32, one

injection of KGF-2 Δ 33 induced a 40-fold increase in proliferation. Following seven daily injections the response had diminished somewhat to an 18-fold increase. Animals treated for seven days and then allowed to recover for seven days had no elevated proliferation demonstrating that this dramatic effect was reversible. This increased proliferation resulted in an increase in organ size. KGF-2 Δ 33 induced a three-fold increase in the weight of the parotid gland after seven daily injections but its size had returned to normal after a seven day recovery period (Figure 33).

Submandibular gland

KGF-2 Δ 33 treatment significantly increased proliferation of the submandibular gland. Both serous and mucous secretory cells are affected although the ducts appear to be resistant to the proliferation-enhancing action of KGF-2 Δ 33. The proliferation was quantitated and the results shown in Figure 34. KGF-2 Δ 33 enhanced growth of cells after 1-3 daily treatments. After seven days there remained a slight elevation in proliferation but this did not attain statistical significance. Unlike the parotid gland, this increase in cellular proliferation was rapidly reflected in an increase in gland weight that started to normalize after treatment was withdrawn for 7 days (Figure 35).

Discussion

Inhibition of saliva and tear production is a major clinical problem and currently the treatment for keratoconjunctivitis sicca alone costs the US over \$100 million (Lemp, M.A, *Adv. Exp. Med. Biol.* 438:791-803 (1998)). The parotid gland is one of the three major salivary glands and is composed of serous cells that secrete a watery substance that contains enzymes such as amylase and lysozyme. The submandibular gland contains both serous and mucous secretory cells and secretes a thicker liquid (*Wheater's functional histology. A text and colour atlas*, New York: Churchill Livingstone, Ed. 3 (1993)).

KGF-2 induced a dramatic increase in the proliferation of the parotid and submandibular glands within 24 hours of the first intravenous injection. The augmented proliferation of the parotid gland remained over the seven day treatment period while the submandibular gland had normalized during seven days of daily administration of KGF-2. These proliferative changes were reflected in the organs by an increase in weight although there were spatial differences in the response.

Continuous infusions of epidermal growth factor (EGF) have been reported to increase proliferation of the parotid and submandibular salivary glands in rats and mice but its effect is more pronounced in the ductal epithelium. Ohlsson *et al.* reported an increase in both the serous and ductal cells following EGF administration in the mouse (Ohlsson, B., *et al.*, *Pancreas* 14:94-98 (1997)). The proliferation occurred in the parotid and submandibular glands after three and seven days of continuous treatment, respectively. There was a higher index of labeling of the ductal rather than the serous cells in the parotid gland and the submandibular gland with 12 and 3 fold increases, respectively. The proliferation of the serous cells in the parotid and submandibular gland reached maximums of 5 and 2 fold, respectively. There was no change in organ weights. Breider *et al.*, working in the rat, found continuous infusions of EGF for four weeks induced proliferation of the salivary gland ductular epithelium but no change of the acinar cells (Breider, M.A., *et al.*, *Vet Pathol* 33:184 (1996)). As compared to EGF, KGF-2 induced a far more pronounced proliferation of the serous epithelium in both salivary glands.

Another growth factor has been reported to induce some changes in the salivary gland. KGF-1, which shares some homology with KGF-2, that has been reported to induce excessive salivation in transgenic mice within five days of birth (Guo, L., *et al.*, *EMBO J.* 12:973-986 (1993)). The submandibular gland of these mice showed an undifferentiated morphology with few or no secretory granules. KGF-2, administered systemically in rats over a period of one week, did not induce such a change in these cells.

In summary, KGF-2 induced dramatic elevations in the proliferation of the saliva and tear producing cells of the salivary and lacrimal glands. It appeared to have little effect on the ductal cells in these organs although careful analysis of both cell types was not performed. These results suggest that KGF-2 may have clinically useful effects on salivary glands damaged as a result of radiation therapy, autoimmune diseases, or other medical conditions.

Example 25

KGF-2Δ33 Induces Proliferation in the Extraorbital Lacrimal Gland

Since KGF-2Δ33 has shown proliferative effects on secretory tissues such as salivary glands and the pancreas, the effect of systemic administration of KGF-2Δ33 on the lacrimal glands was also investigated.

Materials and Methods

Normal male Sprague Dawley rats were injected intravenously daily with KGF-2Δ33 (HG03411-E6) or buffer. Two hours before sacrifice they received a systemic injection of BrdU so that proliferating cells could be detected immunohistologically. The lacrimal glands were excised and then fixed in 10% neutral buffered formalin for histological processing. Animals were used in groups of 6, and the proliferation of the tissue was assessed by a blinded observer using a computerized morphometry unit. The proliferation results are expressed as the percentage of a region of interest that has proliferating cells (% ROI). The error bars reflect the SEM. Statistical analysis was performed using StatView. A factorial ANOVA was performed followed by a Scheffé post-hoc test and statistical significant was defined as $p < 0.05$.

Results

As can be seen from Figure 36, the lacrimal gland proliferates after 1, 2, and 3 daily i.v. treatments with KGF-2Δ33. However, the gland failed to demonstrate elevated proliferation after 7 daily administrations of this growth

factor, a situation that has been observed in many organs and tissues. After 7 daily treatments, and then 7 days of rest, the buffer group displays a higher level of proliferation than the KGF-2 treated animals, possibly due to a down-regulation of KGF-2 receptors.

5 These results suggest that topical or systemic administration of KGF-2Δ33 may stimulate a therapeutic increase in the secretory capacity of the glands by its proliferative effect on lacrimal epithelial cells. These results also suggest that KGF-2 may have clinically useful effects on lacrimal glands damaged as a result of radiation therapy, autoimmune diseases, or other medical conditions.

10

Example 26

The Effect of KGF-2 on the Cornea and Conjunctiva

This experiment was performed to determine the effect of KGF-2 on the cornea and conjunctiva.

Experimental Design

15 KGF-2Δ33 was intravenously injected at 5 mg/kg on a daily basis in male SD rats. The animals were sacrificed at days 1, 2, 3 and 7. Another group of animals were injected for 7 days and allowed to rest for 7 before sacrifice. Two hours before sacrifice, the animals were injected with 100 mg/kg of BrdU. The eyes and the attached conjunctiva were removed. The number of replicating
20 epithelial cells, which had incorporated BrdU, in the cornea and conjunctiva. The results express the replicating epithelia as number of cells per mm of tissue.

Results

Cornea

25 As can be seen from Figure 37, an increase in the number of proliferating cells following KGF-2Δ33 treatment on days 1 and 2 was observed. However,

only the results from day 2 attained statistical significance. A factorial-ANOVA was performed on the results which revealed that there was no interaction between KGF-2Δ33 treatment and time. Therefore, KGF-2Δ33 does not appear to cause proliferation of epithelial cells in the cornea ($p=0.077$). However, as can be seen from the p value, the results approach significance.

Conjunctiva

As can be seen from Figure 38, an increase in the number of proliferating cells following KGF-2Δ33 treatment on days 1, 2 and 3 was observed. However, the number of proliferating cells returned to normal values by the 7th day of treatment. A factorial-ANOVA on the results revealed that KGF-2Δ33 causes proliferation of the epithelial cells in the conjunctiva ($p=0.0024$).

Example 27

The effect of KGF-2 on pilocarpine-induced salivation

Clinical syndromes of xerostomia (dry mouth) result from either radiation therapy to treat head and neck tumors or Sjorgen's Syndrome. Radiation therapy causes severe reduction in the saliva that is produced by a patient and can lead to problems such as difficulty eating and swallowing, mouth sores and lesions, and speech difficulties. Current treatments are sub-optimal. The most common treatment is oral administration of pilocarpine tablets to induce salivation.

Since KGF-2Δ33 exerts a proliferative effect on the cells of the salivary glands, it was interest to determine if KGF-2Δ33 injections also induced a functional difference in treating rats.

Materials and Methods

Normal male Sprague Dawley rats were injected intravenously daily with KGF-2Δ33 or buffer for 7 days. Animals were used in groups of 6. The results

were analyzed using Student's t-test. Saliva was collected after 7 days of injections, by first anesthetizing the rats and then injecting them with pilocarpine HCl (2 mg/kg i.p.).

Results

5 Saliva was collected for 30 minutes directly from the mouth starting at the time of the pilocarpine injection. Saliva volume was calculated from weight and was then assayed for amylase content.

10 As shown in Figure 39 (A), KGF-2Δ33 treatment induces a large increase in saliva production in the treated animals. Figure 39(B) shows that the concentration of amylase in saliva is decreased following the daily KGF-2Δ33 injections. Due to the massive proliferation brought on by KGF-2Δ33 treatment to the secretory acini of the parotid and submandibular salivary glands, it follows that there was an increase in saliva production. Thus, KGF-2 may be useful to treat xerostomia.

15

Example 28

Effect of KGF-2 on Maxillary Sinus and Nasal Septum

20 KGF-2 Δ33 was administered to normal S.D. rats intravenously at a dose of 5mg/kg. Animals were sacrificed 1, 2, 3 and 7 days following treatment. Additionally, one group of rats were injected daily with KGF-2Δ33 for 7 days and allowed to rest for 7 days (Day 14). Two hours prior to sacrifice, each animal was injected with 100mg/kg of BrdU.

25 At the time of sacrifice, animals were decapitated and their nasal cavities were immediately flushed and fixed in neutral phosphate-buffered 10% formalin. The total number of labeled (BrdU) respiratory epithelial cells of both the nasal septum and maxillary sinus were counted and expressed per mm length of tissue.

Results

Maxillary Sinus:

As shown in Figure 40, an increase was observed in the total number of proliferating cells following KGF-2Δ33 treatment on days 1, 2, 3 and 7, all of which attained statistical significance (Factorial-ANOVA: $p=.0024$, $<.0001$, $.0190$ and $.0374$, respectively). The number of proliferating cells returned to normal by Day 14.

Nasal Septum:

As shown in Figure 41, the trend seen in the respiratory epithelium of the maxillary sinus was also mirrored in that of the nasal septum. There was an increase in the total number of proliferating cells following KGF-2Δ33 treatment on Days 1, 2, 3 and 7. All days, except Day 14, attained statistical significance (Factorial-ANOVA: $p=.0022$, $<.0001$, $<.0001$ and $.0171$, respectively). By day 14, the number of proliferating cells returned to normal.

Conclusion

At a dose of 5mg/kg, KGF-2Δ33 causes a significant increase in the total number of Brdu labeled epithelial cells of both the maxillary sinus and nasal septum. By Day 14, the proliferation returns to normal levels.

Example 29

Effect of KGF-2 on Goblet Cells in the Conjunctiva

KGF-2Δ33 was administered to male SD rats intravenously at a dose of 5mg/kg. The animals were sacrificed at days 1, 2, 3 and 7; additional rats were injected for 7 days and allowed to rest for 7 more days before sacrifice. The eyes and the attached conjunctiva were removed. The tissue was stained with PAS stain, and the number of PAS-positive cells (Goblet cells) in the conjunctiva was

counted. The results are expressed as number of goblet cells per millimeter of tissue.

Results

During the treatment period (days 1, 2, 3 and 7), there were no differences
5 between the two treatment groups, KGF-2 Δ 33 and buffer. Animals that were
treated for 7 days with KGF-2 Δ 33, and allowed to rest for 7 more days (Day 14
group on graph), had a higher number of goblet cells than those treated with
buffer. This difference approached statistical significance ($p=0.085$, Scheffe's
post-hoc test). The results are shown in Figure 42.

10

Example 30

Effect of KGF-2 on In Vivo Lung Proliferation

Methods

Male Sprague Dawley rats (approximately 200g, $n=5$ per group) were
anesthetized with isoflurane gas while in a supine position. Buffer or KGF-2 Δ 33
15 (1 or 5 mg/kg) was administered intravenously (i.v.) via the tail vein in a volume
of 0.5 ml. A single i.v. dose of KGF-2 Δ 33 or placebo was administered on
experimental day 1. Animals were euthanized at 6, 24 or 48 hours following i.v.
injection. On the day of euthanasia, the rats were injected i.p. with 100 mg/kg
BrdU two hours prior to sacrifice. Euthanasia was carried out by anesthetizing
20 with ketamine/xylazine followed by cervical dislocation.

Lung Tissue Harvest

A longitudinal skin incision was made from the sternal region to the chin.
The left superior vena cava was clamped and the thoracic cavity was opened
through the sternal borders and separated from the ribs. The lungs were released

from the diaphragm and the pulmonary system was flushed of blood by injecting saline (10-15 mL) into the right ventricle. The blood/saline exited the pulmonary system via the left atrium. The left lobe was clamped at the main bronchus with artery forceps, while the right lung was inflated with 10-15 mL of 10% formalin via a slit hole in the trachea over the neck region, clamped and allowed to fix for about five minutes. The upper right lung and lower right was then removed, placed in a tissue cassette and immersed in 10% formalin for 24 hours. Lung tissue was placed in 70% alcohol and submitted for histopathological analysis. Tissue was embedded in paraffin, cross-sectioned and stained with H&E and a mouse anti-BrdU monoclonal antibody.

Histological Analysis

The number BrdU positive cells was counted under light microscopy at a magnification of 20X. 10 random fields were counted from each tissue sample. Counting was done by two independent observers who were blind to the treatment groups.

Statistical Analysis

All statistical analysis was accomplished using Instat v2.01. Experimental data was analyzed using an unpaired t test. A p value of < 0.05 was considered significant. The data expressed as the mean \pm SEM.

Results

The results of the BrdU proliferation studies are shown in Figure 43. In rats receiving buffer, there were approximately 36 BrdU positive cells per field under 20x magnification. At 24 hours after a single i.v. treatment of 1 mg/kg KGF-2 Δ 33, 97 BrdU positive cells per field were observed; an increase that was significant ($p=0.0118$) relative to the KGF-2 buffer control group. Rats receiving 5 mg/kg KGF-2 Δ 33 exhibited a significant increase in BrdU positive cells per field (197 cell per field; $p<0.0001$) when compared to the buffer control (37 cells

per field). At the 6 and 48 hour time points, there were no differences observed between the groups with regard to the number of BrdU positive cells.

Conclusion

5 At 6 hours after i.v. injection of KGF-2 Δ 33, no increase in proliferation was observed by BrdU immunostaining.

A single i.v. administration of KGF-2 Δ 33 at 5 mg/kg resulted in a significant increase in BrdU immunostaining in the lung relative to buffer controls in both experiments.

10 In one of two experiments performed, an i.v. dose of 1 mg/kg KGF-2 Δ 33 resulted in a significant increase in BrdU immunostaining relative to buffer control.

At 48 hours after i.v. administration of KGF-2 Δ 33, there was no observed difference in proliferation of lung cells among the groups.

Example 31

Effect of Nebulized KGF-2 on In Vivo Lung Proliferation

Methods

20 Male Lewis or SD rats (250-350 g, n=5 per group) were anesthetized with intramuscular ketamine/xylazine to immobilize them during the exposure period. A Pari-Proneb LC Jet+ nebulizer was used to nebulize buffer or KGF-2 Δ 33. This nebulizer delivers a range of particle sizes whereby 74% of the particles are <5 μ m in size and 24% of the particles are <2 μ m in size. Rats inhaled nebulized buffer of KGF-2 Δ 33 (6 or 12 mg/rat) over a period of 45 to 60 minutes. Twenty-four hours after the exposure period, (Day 2), the rats were injected i.p. with

100mg/kg BrdU two hours prior to sacrifice. Euthanasia was carried out by CO₂ asphyxiation for tissue harvesting.

Lung Tissue Harvest

5 A longitudinal skin incision was made from the sternum region to the chin. The left superior vena cava was clamped and the thoracic cavity was opened through the sternal borders and separated from the ribs. The lungs were released from the diaphragm. The pulmonary system was flushed of blood by injecting saline (10-15 mL) into the right ventricle. The blood/saline exited the pulmonary system via left auricle. The left lobe was clamped at the main
10 bronchus with artery forceps, removed and snap frozen in liquid nitrogen for collagen content assay. The right lung was insufflated with 10-15 mL of 10% formalin via a slit hole in the trachea over the neck region, clamped and allowed to fix for about five minutes. The upper right lung and lower right was then removed, placed in a tissue cassette and immersed in 10% formalin for 24 hours.
15 Lung tissue was placed in 70% alcohol and submitted for hisopathological analysis. Tissue was embedded in paraffin, cross-sectioned and stained with H&E and a mouse anti-BrdU monoclonal antibody.

Histological Analysis

20 The number BrdU positive cells was counted under light microscopy at a magnification of 20X. Ten random fields were counted from each tissue sample. Counting was done by two independent observers who were blind to the treatment groups.

Statistical Analysis

25 All statistical analysis was accomplished using Instat v2.01. Experimental data was analyzed using an unpaired t test. A p value of < 0.05 was considered significant. The data was expressed as the mean \pm SEM.

Nebulizer Design

Five animals treated simultaneously on one nebulizer unit.

Results

Microscopic Observations

5 Upon histological observation of the BrdU cell counts, rats treated with KGF-2Δ33 buffer (n=5) had an average of 9 BrdU positive cells per field. Treatment with KGF-2Δ33 at 6 mg/rat (n=5) produced a not quite significant increase to 20 BrdU positive cells per field ($p=0.0857$) when compared to the buffer control. Treatment KGF-2Δ33 at 12 mg/rat (n=5) resulted in a significant
10 increase in BrdU positive cells per field (32 cells per field; $p=0.001$) when compared to the buffer control. The results are shown in Figure 44.

Example 32

Prophylactic KGF-2 Δ33 in Bleomycin Lung Damage

15 The purpose of this example was to examine the effect of KGF-2Δ33 in the bleomycin-induced rat model of lung injury. Bleomycin causes fibrosis of the lung. KGF-2Δ33 was tested for its prophylactic (protective) effect in the lungs. Parameters that were evaluated include body weight, histology, lung collagen content.

Methods

20 Male Lewis rats (200-250 g, n=5 to 8 per group) were anesthetized with isoflurane gas and while in a supine position. A pharyngo-laryngo fiberscope was used to locate the pharynx and a metal feeding tube (20 gauge) attached to a 5 ml syringe was inserted into the trachea. Buffer or KGF-2 Δ33 (0.5, 1 or 5mg/kg) was administered intratracheally (i.t.) into the lungs in a volume of 0.6 ml

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5 followed by 4 cc of air on days 1 and 2 of the experiment. The air was then used to drive the liquid into the lungs. The rats were quickly placed in a recumbent position and allowed to recover. Resuscitation was done if necessary. On day 3 of the experiment, bleomycin (5units/0.5ml) was administered intratracheally to all the animals except for the no treatment group. Clinical observations were made daily (e.g. weight loss, death etc.) On the last day of the experiment (Day 14), the rats were injected i.p. with 100mg/kg BrdU two hours prior to sacrifice. Euthanasia was carried out by CO₂ asphyxiation for tissue harvesting, histopathological analysis and lung collagen content assay.

10

Lung Tissue Harvest

A longitudinal skin incision was made from the xiphisternal region to the neck region. The thoracic cavity was opened through the sternal borders and separated from the ribs. The lungs were released from the diaphragm and the left lobe was clamped at the main bronchus with artery forceps, removed and snap frozen in liquid nitrogen for collagen content assay. The right lung was inflated with 10% formalin via a slit hole in the trachea over the neck region, clamped and allowed to fix for about five minutes. The right lung was then removed, placed in a tissue cassette and immersed in 10% formalin for 24 hours. Lung tissue was placed in 70% alcohol and submitted for histopathological analysis. Tissue was embedded in paraffin, cross-sectioned and stained with H&E and mouse anti-BrdU monoclonal antibody.

20

Histological Analysis

The number of BrdU positive cells was counted under light microscopy at a magnification of 20X. Ten random fields were counted from each tissue sample. Counting was performed by two independent observers who were blinded to the treatment groups.

25

Statistical Analysis

All statistical analysis was accomplished using Instat v2.01. Experimental data was analyzed using an unpaired t test. A p value of < 0.05 was considered significant. The data was expressed as the mean \pm SEM.

5 *Results*

Body Weight

Figure 45 shows the body weights of the animals during this experiment. Animals in the "no treatment" group continued to increase in weight throughout the experiment. Animals receiving bleomycin and KGF-2 buffer lost weight during the experiment until day 7. Following day 7, these animals began to gain weight. In the treatment groups, KGF-2 $\Delta 33$ at a dose of 1mg/kg, was able to prevent the weight loss observed in the other groups receiving bleomycin. This difference in body weight was seen on days 5, 7 and 9 relative to the buffer placebo group. Animals receiving 0.5 or 5 mg/kg KGF-2 $\Delta 33$ had body weights that were similar to the KGF-2 buffer controls.

Microscopic Observations

No architectural damage was observed in H&E stained sections of the lung parenchyma of the "no treatment" group animals. Fibrosis scoring was done using a scale ranging from 0-9, (0=normal, 1-3=mild, 4-6=moderate, 7-9=severe). Animals in the no treatment groups had a mean score of 0.56. Architectural damage was observed in all other treatment groups (groups receiving bleomycin). As shown in Figure 46, rats treated with bleomycin and KGF-2 buffer had a mean fibrosis score of 4.24 (** $p < 0.0001$) a significant change relative to the no treatment group. Animals receiving KGF-2 $\Delta 33$ displayed significant reductions in fibrosis scores at 0.5mg/kg KGF-2 $\Delta 33$ (2.91, * $p = 0.0248$), 1mg/kg KGF-2 $\Delta 33$ (2.07, $p = 0.0004$) and 5mg/kg KGF-2 $\Delta 33$ (1.98, $p = 0.0005$) when compared to the KGF-2 buffer placebo group.

Cell proliferation, shown in Figure 47, was assessed by counting the number of BrdU positive cells per field. In a normal rat the lungs have an average of 7 BrdU positive cells per field illustrating the low level of cell proliferation occurring under normal physiological conditions. When rats were
5 treated with KGF-2 buffer and bleomycin, there was a significant increase in the number of cells per field, 40 ($p < 0.0001$) when compared to the no treatment group. Rats receiving KGF-2 Δ 33 displayed a significantly lower number of BrdU positive cells at doses of 0.5mg/kg (26, $p = 0.0003$) positive 1mg/kg (11, $p < 0.0001$) and at 5mg/kg (24, $p < 0.0001$) when compared to the KGF-2 buffer
10 controls.

These results suggest that KGF-2 may have clinically useful effects on lung fibrosis.

Example 33

Effect of KGF-2 Δ 33 on Bladder Capacity in a Cyclophosphamide-Induced Cystitis Rat Model

15

Experimental Design

Male SD rats (200g) received KGF-2 Δ 33 in doses of 0.1 mg/kg, 0.3 mg/kg, 1.0 mg/kg or 3.0 mg/kg intravenously. On day 1, 200 mg/kg of cyclophosphamide (CP) was administered i.p. Animals were sacrificed on day
20 4. Six animals were used in each experimental group. Experimental groups included a saline control group, a CP only control (200 mg/kg) group, a buffer + CP (200 mg/kg) group a KGF-2 Δ 33 (1.0 mg/kg) + CP (200 mg/kg), and a KGF-2 Δ 33 (3.0 mg/kg) + CP (200 mg/kg) group.

Two additional parameters were performed at the time of sacrifice. These
25 measurements included bladder capacity and bladder wet weight. Bladder capacity was defined as the amount of formalin (in milliliter quantity) injected into the bladder until one drop of formalin is visible exiting from the urethra.

Prior to filling the bladder is emptied of all urine by gently squeezing the bladder and forcing the urine out through the urethra. The bladder is allowed to fix several minutes. Once fixed the bladder is removed, drained and weighed providing a measure of wet weight. (* compared to CP only control; † compared to buffer control).

Results

Microscopic Observations

The bladder capacity of the saline control group was 1.10 ± 0.1 ml. The CP only group was significantly reduced to 0.62 ± 0.15 ml and the buffer control group was 0.45 ± 0.01 ml. The bladder capacity of the KGF-2Δ33 groups treated with 0.3 mg/kg and 1.0 mg/kg (1.20 ± 0.25 ml, $p = 0.0206$; 1.28 ± 0.27 , $p = 0.0172$, respectively) were significantly increased compared to the buffer control. The bladder capacity of the KGF-2Δ33 at 3.0 mg/kg (1.72 ± 0.28 , $p = 0.28$ ml) was significantly increased compared to the CP only control ($p = 0.0066$) and the buffer-treated control ($p = 0.0018$). The results are shown in Figure 48.

The bladder wet weight of the saline control group was 0.11 mg. The wet weight of the CP only group was 0.22 ± 0.01 mg and that of buffer control was 0.19 ± 0.01 mg. The KGF-2Δ33 group (0.3 mg/kg) wet weight (0.15 ± 0.007 mg) was significantly reduced compared to the CP only control ($p = 0.0015$) and almost significantly reduced compared to the buffer-treated control ($p = 0.0595$) group. The KGF-2Δ33 groups treated with 1.0 mg/kg (0.15 ± 0.02 mg; $p = 0.0314$) and 3.0 mg/kg (0.149 ± 0.01 mg, $p = 0.0057$) were significantly reduced in bladder wet weight compared to the buffer-treated control. These results are shown in Figure 49.

Example 34

Effect of KGF-2 Δ33 and Mesna in Cyclophosphamide-Induced Cystitis

The effect of KGF-2Δ33 and mesna on bladder wall thickness, bladder ulceration and urothelium was examined in the cyclophosphamide-induced cystitis rat model. Mesna is currently used as a prophylactic agent for the prevention of hemorrhagic cystitis induced by cyclophosphamide or structural analogs.

Experimental Method and Design

Male SD rats (300-400 g) received either buffer or 5.0 mg/kg KGF-2Δ33 intravenously via the tail vein on day 0. On day 1, 200 mg/kg of cyclophosphamide (CP) i.p and Mesna (20 μg/g or 40 μg/g,) i.v. via the tail vein. One group of animals was injected i.p. with saline as a CP control. Five animals were used in each experimental group. Experimental groups included saline control group, a CP only control group (200 mg/kg), a Mesna (20 mg/kg) + CP (200 mg/kg) group, a Mesna (40 mg/kg) + CP (200 mg/kg) group, a buffer + CP (200 mg/kg) group, and a KGF-2Δ33 (5 mg/kg) + CP (200 mg/kg) group.

Animals were sacrificed on day 3, 48 hours after CP injection the animals were injected with 100 mg/kg of BrdU. Two hour later the animals were euthanized by CO₂ asphyxiation. The bladders were fixed for histological processing by direct injection of 10% formalin into the lumen of the bladder and rinsing of the exterior of the bladder with formalin. After 5 minutes, the bladders were harvested. The urinary bladders were paraffin embedded, cross-sectioned and stained with H&E and a mouse anti-BrdU monoclonal antibody.

The extent of urothelial damage was assessed using the following scoring system: Urothelial damage (ulceration) was scored as 0-100% (in units of 10) loss of the urothelium. The amount of normal urothelium was assessed and scored as 0-100% (in increments of 10%). Normal urothelium was defined as a dense stratified epithelium containing at least a thickness a single layer of cells appearing as tall columnar or cuboidal cells with round nuclei. In addition, the thickness of the bladder wall was measured at 10 random sites per section and expressed in μm. This measurement included the distance from the urothelium

through the smooth muscle layers to serosal surface. All histology measurements were performed by blinded observers. Statistical analysis was performed using the students unpaired t-test on Instat 2.01 where significance is found if $p \leq 0.05$.

5 **Results**

Microscopic Observations

 In normal rats treated i.p. with saline (CP vehicle control), the bladder wall was not enlarged and no ulceration of the urothelium was observed. Pretreatment with buffer placebo 24 hours prior to i.p. administration of CP (200
10 mg/kg) resulted in $43\% \pm 19$ ulceration of the total bladder epithelial area. Administration of KGF-2 $\Delta 33$ 24 hours prior to CP resulted in a reduction in the extent of ulceration ($1.4\% \pm 0.24$; $p = 0.0641$) when compared to placebo treated animals receiving CP. Administration of Mesna at 20 or 40 mg/kg resulted in a reduction of ulceration to $1.4\% \pm 0.24$ or $6.2\% \pm 4.7$, respectively however these
15 values were not statistically significant relative to the control. These results are shown in Figure 50.

 In some cases the urothelial lining may not exhibit ulceration but may still be abnormal in appearance. Thus, the "percent normal urothelial" was established as a measure of the amount of urothelium with columnar or cuboidal morphology,
20 rounded nuclei, and possessing at least 1 cell layer in thickness. Groups treated with KGF-2 $\Delta 33$ 24 hours prior to CP administration had $97\% \pm 3$ normal urothelium ($p = 0.0574$) and $93\% \pm 3$ ($p = 0.0625$) normal urothelium respectively. These values were considered to be not quite significant when compared to the CP only group. These results are shown in Figure 51.

25 The thickness of the urinary bladder wall was also evaluated as an additional measure of CP damage. Bladder wall thickness was measured from the epithelium through smooth muscle layers to the serosal surface. In groups treated with saline (CP vehicle control) alone, the thickness of the bladder wall is approximately $100 \mu\text{m} \pm 16$. KGF-2 $\Delta 33$ pretreatment ($252 \mu\text{m} \pm 30$; $p = 0.0331$
30 ± 29). Mesna treatment also resulted in significant decreases in bladder wall

thickness at 20 mg/kg ($198 \mu\text{m} \pm 34$; $p = 0.0361$) and 40 mg/kg ($172 \mu\text{m} \pm 46$; $p = 0.0215$) when compared to the CP only group. These results are shown in Figure 52.

Example 35

5 *Synergistic Effect of KGF-2 $\Delta 33$ and Mesna in Cyclophosphamide-Induced Cystitis*

The synergistic effect of KGF-2 $\Delta 33$ and mesna on bladder capacity and bladder wet weight in cyclophosphamide-induced cystitis rat model was examined.

10 *Experimental Design*

Male SD rats (350-400 g) ($n=7$) received, on day 0, either buffer or 5.0 mg/kg KGF-2 $\Delta 33$ intravenously and on day 1, Mesna (40 $\mu\text{g/g}$, i.v.) or both treatments on the respective administration days. Cyclophosphamide (300 mg/kg, i.p.) was administered on day 1 to all treatment groups with the exception of the saline control. One group was added as a CP control with no treatment. On day 15 3, animals received BrdU (100mg/kg, i.p.) 2 hours prior to euthanasia. After urine was removed from the bladder, it was filled with formalin until it leaked out of the urethra. The volume of formalin injected into the bladder was recorded as the bladder capacity. Bladders were fixed with 10% neutral-buffered formalin, weighed and placed in tissue cassettes for histological analysis.

20 The experimental groups consisted of six animals per group. The following experimental groups were used: a saline control group, a CP only control (300 mg/kg) group, a buffer + CP (300 mg/kg) group, a KGF-2 $\Delta 33$ (3.0 mg/kg) + a CP (300 mg/kg) group, a Mesna (40 mg/kg) + CP (300 mg/kg) group, 25 and a KGF-2 $\Delta 33$ (3.0 mg/kg) + CP (300 mg/kg) + Mesna (40 mg/kg).

Results

The bladder capacity of the saline control group was 2.21 ± 0.1 ml. The group receiving CP only had a significantly reduced bladder capacity of 0.80 ± 0.27 ml while the buffer control was 0.40 ± 0.15 ml. The bladder capacity of the KGF-2 $\Delta 33$ treated group (1.66 ± 0.31 ml, $p = 0.0038$) was significantly increased when compared to the buffer control. Likewise, the Mesna (40 mg/kg) group (1.67 ± 0.44 ml, $p = 0.0147$) was significantly increased in comparison to the buffer control. The animals treated with both KGF-2 $\Delta 33$ and Mesna (1.96 ± 0.19 ml) also displayed a significant increase in capacity when compared to CP only control ($p=0.0044$) and the buffer control group ($p<0.0001$). These results are shown in Figure 53.

The bladder wet weight of the saline control group was 0.16 mg. The wet weight of the CP only control was 0.30 ± 0.01 mg. The KGF-2 $\Delta 33$ group (0.33 ± 0.3 mg) and the Mesna group (0.28 ± 0.03 mg) were no significantly different from the control groups. However, animals treated with both KGF-2 $\Delta 33$ and Mesna exhibited a significant reduction in bladder wet weight (0.19 ± 0.08 mg) when compared to the CP only group ($p=0.193$) and the buffer control ($p=0.0099$). These results are shown in Figure 54.

Example 36

20 *KGF-2 $\Delta 33$ Induced Changes in Buccal Mucosa and Tongue*

In cynomolgus monkeys, daily intravascular injections of KGF-2 $\Delta 33$ at 300 μ g/kg resulted in grossly visible thickening of the oral (buccal) and esophageal mucosa. Microscopically, hyperkeratosis of the buccal mucosa, tongue and esophagus were noted in monkeys treated both daily and every other day with KGF-2 $\Delta 33$. The buccal and esophageal mucosa hyperkeratosis correlated with the grossly visible thickening of the buccal and esophageal mucosa.

*Example 37**KGF-2 Δ 33 Induced Goblet Cell Changes*

5 In male Sprague Dawley rats, daily intravenous injections of KGF-2 Δ 33 at 5 mg/kg resulted in goblet cell hyperplasia in the respiratory epithelium of the nasal air passage way. This was characterized by a minimal to mild goblet cell hyperplasia after 7 consecutive days of KGF-2 Δ 33 treatment followed by a 7 day treatment-free period.

It will be clear that the invention may be practiced otherwise than as particularly described in the foregoing description and examples.

10 Numerous modifications and variations of the present invention are possible in light of the above teachings and, therefore, within the scope of the appended claims, the invention may be practiced otherwise than as particularly described.

15 The entire disclosure of all publications (including patents, patent applications, journal articles, laboratory manuals, books, or other documents) cited herein are hereby incorporated by reference.

180.1

Applicant's or agent's file reference number 1488.106PC02	International application No. Tb.
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INDICATIONS RELATING TO A DEPOSITED MICROORGANISM
(PCT Rule 13bis)

A. The indications made below relate to the microorganism referred to in the description on page 6, lines 22 and 23.	
B. IDENTIFICATION OF DEPOSIT Further deposits are identified on an additional sheet <input checked="" type="checkbox"/>	
Name of depositary institution American Type Culture Collection (ATCC)	
Address of depositary institution (including postal code and country) <div style="display: flex; justify-content: space-between;"> <div>10801 University Boulevard Manassas, Virginia 20110-2209 United States of America</div> <div>Formerly at: 12301 Parklawn Drive Rockville, Maryland 20852 United States of America</div> </div>	
Date of deposit 16 December 1994	Accession Number ATCC 75977
C. ADDITIONAL INDICATIONS (leave blank if not applicable) This information is continued on an additional sheet <input type="checkbox"/>	
DNA Plasmid 366885A	
D. DESIGNATED STATES FOR WHICH INDICATIONS ARE MADE (if the indications are not for all designated States)	
E. SEPARATE FURNISHING OF INDICATIONS (leave blank if not applicable)	
The indications listed below will be submitted to the international Bureau later (specify the general nature of the indications, e.g., "Accession Number of Deposit")	

For receiving Office use only	For International Bureau use only
<input type="checkbox"/> This sheet was received with the international application	<input type="checkbox"/> This sheet was received by the International Bureau on:
Authorized officer	Authorized officer

180.2

Applicant's or agent's file reference number 1488.106PC02	International application No. 1488.106PC02
--	---

INDICATIONS RELATING TO A DEPOSITED MICROORGANISM
(PCT Rule 13bis)

A. The indications made below relate to the microorganism referred to in the description on page 59, lines 28 and 29.	
B. IDENTIFICATION OF DEPOSIT Further deposits are identified on an additional sheet <input type="checkbox"/>	
Name of depositary institution American Type Culture Collection (ATCC)	
Address of depositary institution (including postal code and country) 10801 University Boulevard Manassas, Virginia 20110-2209 United States of America	
Formerly at:	12301 Parklawn Drive Rockville, Maryland 20852 United States of America
Date of deposit 09 January 1998	Accession Number ATCC 209575
C. ADDITIONAL INDICATIONS (leave blank if not applicable) This information is continued on an additional sheet <input type="checkbox"/>	
DNA Plasmid pHEKGF-2delta33	
D. DESIGNATED STATES FOR WHICH INDICATIONS ARE MADE (if the indications are not for all designated States)	
E. SEPARATE FURNISHING OF INDICATIONS (leave blank if not applicable)	
The indications listed below will be submitted to the international Bureau later (specify the general nature of the indications, e.g., "Accession Number of Deposit")	

For receiving Office use only	For International Bureau use only
<input type="checkbox"/> This sheet was received with the international application	<input type="checkbox"/> This sheet was received by the International Bureau on:
Authorized officer	Authorized officer

What Is Claimed Is:

1. A method of increasing the level of platelets in blood comprising administering to an individual a polypeptide selected from the group consisting of:

5 (a) a polypeptide comprising an amino acid sequence at least 95% identical to Arg (80) - Ser (208) of SEQ ID NO:2; and

(b) a polypeptide comprising an amino acid sequence identical to Arg (80) - Ser (208) of SEQ ID NO:2 except for at least one but not more than twenty amino acid substitutions;

10 wherein said polypeptide is administered in an amount effective to increase the platelet level in said individual's blood.

2. The method of claim 1, wherein said polypeptide is administered to alleviate thrombocytopenia.

15 3. The method of claim 2, wherein said thrombocytopenia is caused by disease or condition selected from the group consisting of: drug induced hypersensitivity, idiopathic thrombocytopenia purpura (ITP), posttransfusion purpura, neonatal thrombocytopenia, metastatic tumors in the bone, aplastic anemia, myelofibrosis, leukemia, microangiopathic hemolytic anemia, thrombotic thrombocytopenic purpura (TTP), hemolytic-uremic syndrome, prosthetic valve
20 hemolytic syndrome, cancer chemotherapy, Zieve's syndrome, sepsis, HELLP preeclamptic syndrome, megaloblastic anemia due to B12 and folic acid deficiency, peritonitis, congenital rubella syndrome, HIV-1 virus infection, Epstein-Barr infectious mononucleosis, systemic lupus, preeclampsia, thyrotoxicosis, uremia, and disseminated intravascular coagulation (DIC).

25 4. A method of increasing the level of plasma fibrinogen comprising administering to an individual a polypeptide selected from the group consisting of:

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(a) a polypeptide comprising an amino acid sequence at least 95% identical to Arg (80) - Ser (208) of SEQ ID NO:2; and

(b) a polypeptide comprising an amino acid sequence identical to Arg (80) - Ser (208) of SEQ ID NO:2 except for at least one but not more than twenty amino acid substitutions;

wherein said polypeptide is administered in an amount effective to increase the level of plasma fibrinogen.

5 5. The method of claim 4, wherein said polypeptide is administered to alleviate hypofibrinogenemia.

10 6. The method of claim 5, wherein said hypofibrinogenemia is caused by a disease or condition selected from the group consisting of: hepatitis, cirrhosis, and disseminated intravascular coagulation (DIC)

15 7. A method of increasing the level of serum albumin comprising administering to an individual a polypeptide selected from the group consisting of:

(a) a polypeptide comprising an amino acid sequence at least 95% identical to Arg (80) - Ser (208) of SEQ ID NO:2; and

(b) a polypeptide comprising an amino acid sequence identical to Arg (80) - Ser (208) of SEQ ID NO:2 except for at least one but not more than twenty amino acid substitutions;

20 wherein said polypeptide is administered in an amount effective to increase the level of serum albumin.

8. The method of claim 7, wherein said polypeptide is administered to alleviate hypoalbuminemia.

25 9. The method of claim 8, wherein said hypoalbuminemia is caused by a disease or condition selected from the group consisting of: hemorrhages,

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burns, exudates, rheumatic diseases, granulomatous processes, bacterial infections, viral infections accompanied by tissue destruction, tissue necrosis, vasculitis, ulcerative bowel disease, serositis, subacute bacterial endocarditis, parasitic infestations, acute and chronic liver disease, amyloidosis, malnutrition, malignancy, congestive heart failure, constrictive pericarditis, cardiac valvular disease, nephrotic syndrome, trauma and crush injuries, gastrointestinal and lymphatic fistulae, and protein-losing gastroenteropathies.

10. A method of increasing the level of serum globulin comprising administering to an individual a polypeptide selected from the group consisting of:

(a) a polypeptide comprising an amino acid sequence at least 95% identical to Arg (80) - Ser (208) of SEQ ID NO:2; and

(b) a polypeptide comprising an amino acid sequence identical to Arg (80) - Ser (208) of SEQ ID NO:2 except for at least one but not more than twenty amino acid substitutions;

wherein said polypeptide is administered in an amount effective to increase the level of serum globulin.

11. The method of claim 10, wherein said polypeptide is administered to alleviate hypoglobulinemia.

12. The method of claim 11, wherein said hypoglobulinemia is caused by a disease or condition selected from the group consisting of: alpha-1 antitrypsin deficiencies, severe liver disease, estrogen therapy, megaloblastic anemia, hypogammaglobulinemia and agammaglobulinemia

13. A method of increasing the level of total serum protein comprising administering to an individual a polypeptide selected from the group consisting of:

(a) a polypeptide comprising an amino acid sequence at least 95% identical to Arg (80) - Ser (208) of SEQ ID NO:2; and

(b) a polypeptide comprising an amino acid sequence identical to Arg (80) - Ser (208) of SEQ ID NO:2 except for at least one but not more than twenty amino acid substitutions;

wherein said polypeptide is administered in an amount effective to increase the level of total serum protein.

14. The method of claim 13, wherein said polypeptide is administered to alleviate total protein loss.

15. The method of claim 14, wherein said total serum protein loss is caused by a disease or condition selected from the group consisting of : protein-losing gastroenteropathies, acute burns, nephrotic syndrome, chronic liver disease, malabsorption syndrome, malnutrition, and agammaglobulinemia.

16. A method of reducing damage caused by an inhibition of normal proliferation of epithelial cells of the bladder or prostate comprising administering to an individual a polypeptide selected from the group consisting of:

(a) a polypeptide comprising an amino acid sequence at least 95% identical to Arg (80) - Ser (208) of SEQ ID NO:2; and

(b) a polypeptide comprising an amino acid sequence identical to Arg (80) - Ser (208) of SEQ ID NO:2 except for at least one but not more than twenty amino acid substitutions;

wherein said polypeptide is administered in an amount effective to reduce damage caused by an inhibition of normal proliferation of epithelial cells of the bladder or prostate.

17. The method of claim 16, wherein normal proliferation of epithelial cells of the bladder or prostate is inhibited by radiation treatment or by administration of an antineoplastic drug.

5 18. The method of claim 17, wherein said antineoplastic drug is cyclophosphamide.

19. The method of claim 16, wherein said polypeptide is administered to prevent or reduce damage caused by hemorrhagic cystitis.

20. The method of claim 17, wherein said polypeptide is administered prior to said radiation treatment or administration of an antineoplastic drug.

10 21. The method of claim 17, wherein said polypeptide is administered to increase bladder load.

22. The method of claim 17, further comprising administering an effective amount of mesna.

15 23. A method of stimulating proliferation of salivary gland cells comprising administering to an individual a polypeptide selected from the group consisting of:

(a) a polypeptide comprising an amino acid sequence at least 95% identical to Arg (80) - Ser (208) of SEQ ID NO:2; and

20 (b) a polypeptide comprising an amino acid sequence identical to Arg (80) - Ser (208) of SEQ ID NO:2 except for at least one but not more than twenty amino acid substitutions;

wherein said polypeptide is administered in an amount effective to stimulate proliferation of salivary gland cells.

24. The method of claim 23, wherein said polypeptide is administered in an amount effective to stimulate proliferation of the submandibular salivary gland cells.

5 25. The method of claim 23, wherein said polypeptide is administered in an amount effective to stimulate proliferation of the parotid salivary gland cells.

26. The method of claim 23, wherein said polypeptide is administered in an amount effective to stimulate proliferation of the sublingual salivary gland cells.

10 27. The method of claim 24, wherein said submandibular salivary gland cells are serous secretory cells.

28. The method of claim 24, wherein said submandibular salivary gland cells are mucous secretory cells.

15 29. The method of claim 24, wherein said parotid salivary gland cells are serous secretory acini cells.

30. The method of claim 23, wherein said polypeptide is administered to treat or reduce salivary gland dysfunction.

20 31. A method of stimulating proliferation of lacrimal gland cells comprising administering to an individual a polypeptide selected from the group consisting of:

(a) a polypeptide comprising an amino acid sequence at least 95% identical to Arg (80) - Ser (208) of SEQ ID NO:2; and

(b) a polypeptide comprising an amino acid sequence identical to Arg (80) - Ser (208) of SEQ ID NO:2 except for at least one but not more than twenty amino acid substitutions;

5 wherein said polypeptide is administered in an amount effective to stimulate proliferation of lacrimal gland cells.

32. The method of claim 31, wherein said lacrimal gland cells are secretory cells.

33. The method of claim 31, wherein said polypeptide is administered in an amount effective to treat or reduce lacrimal gland dysfunction.

10 34. The method of claim 33, wherein said polypeptide is administered to treat or reduce lacrimal gland dysfunction caused by radiation therapy, autoimmune disease, aging, HIV, keratoconjunctivitis sicca, burns or other medical conditions.

15 35. A method of stimulating proliferation of the sinus epithelium comprising administering to an individual a polypeptide selected from the group consisting of:

(a) a polypeptide comprising an amino acid sequence at least 95% identical to Arg (80) - Ser (208) of SEQ ID NO:2; and

20 (b) a polypeptide comprising an amino acid sequence identical to Arg (80) - Ser (208) of SEQ ID NO:2 except for at least one but not more than twenty amino acid substitutions;

wherein said polypeptide is administered in an amount effective to stimulate the sinus epithelium.

25 36. The method of claim 35, wherein said polypeptide is administered in an amount effective to treat or reduce damage to the sinus epithelium.

37. The method of claim 36, wherein said polypeptide is administered to treat or reduce damage to the sinus epithelium caused by surgery, wounds, or other medical conditions.

5 38. The method of claim 36, wherein said polypeptide is administered to reduce infection, scarring, polyps, cyst formation and recurrence.

39. A method of stimulating proliferation of Goblet cells comprising administering to an individual a polypeptide selected from the group consisting of:

10 (a) a polypeptide comprising an amino acid sequence at least 95% identical to Arg (80) - Ser (208) of SEQ ID NO:2; and

(b) a polypeptide comprising an amino acid sequence identical to Arg (80) - Ser (208) of SEQ ID NO:2 except for at least one but not more than twenty amino acid substitutions;

15 wherein said polypeptide is administered in an amount effective to stimulate proliferation of Goblet cells.

40. The method of claim 39, wherein said Goblet cells are in the respiratory epithelium of the nasal air passage way.

41. The method of claim 39, wherein said Goblet cells are in the large or small intestine.

20 42. The method of claim 39, wherein said Goblet cells are in the conjunctiva.

43. The method of claim 39, wherein said polypeptide is administered for treating or preventing keratoconjunctivitis sicca.

44. The method of claim 1, wherein said polypeptide is administered with a pharmaceutically acceptable carrier or excipient.

5 45. The method of claim 1, wherein said polypeptide is administered by a route selected from the group consisting of intravenously, subcutaneously and intraperitoneally.

46. The method of claim 1, wherein said polypeptide is (a).

47. The method of claim 46, wherein said polypeptide comprises Arg (80) - Ser (208) of SEQ ID NO:2.

10 48. The method of claim 46, wherein said polypeptide comprises an amino acid sequence at least 95% identical to Val(77) to Ser(208) of SEQ ID NO:2.

49. The method of claim 48, wherein said polypeptide comprises Val(77) to Ser(208) of SEQ ID NO:2.

15 50. The method of claim 46, wherein said polypeptide comprises an amino acid sequence at least 95% identical to Ser(69) to Ser(208) of SEQ ID NO:2.

51. The method of claim 50, wherein said polypeptide comprises Ser(69) to Ser(208) of SEQ ID NO:2.

20 52. The method of claim 46, wherein said polypeptide comprises an amino acid sequence at least 95% identical to Ala (63) - Ser (208) of SEQ ID NO:2.

53. The method of claim 52, wherein said polypeptide comprises Ala (63) - Ser (208) of SEQ ID NO:2.

5 54. The method of claim 46, wherein said polypeptide comprises an amino acid sequence at least 95% identical to Cys (37) - Ser (208) of SEQ ID NO:2.

55. The method of claim 54, wherein said polypeptide comprises Cys (37) - Ser (208) of SEQ ID NO:2.

10 56. The method of claim 46, wherein said polypeptide comprises an amino acid sequence at least 95% identical to Thr (36) - Ser (208) of SEQ ID NO:2.

57. The method of claim 56, wherein said polypeptide comprises Thr (36) - Ser (208) of SEQ ID NO:2.

15 58. The method of claim 46, wherein said polypeptide comprises an amino acid sequence at least 95% identical to Trp (2) - Ser (208) of SEQ ID NO:2.

59. The method of claim 58, wherein said polypeptide comprises Trp (2) - Ser (208) of SEQ ID NO:2.

20 60. The method of claim 46, wherein said polypeptide comprises an amino acid sequence at least 95% identical to Met (1) - Ser (208) of SEQ ID NO:2.

61. The method of claim 60, wherein said polypeptide comprises Met (1) - Ser (208) of SEQ ID NO:2.

62. The method of claim 47, 49, 51, 53, 55, or 57, having a Met residue at the N-terminus.

63. The method of claim 51, wherein said polypeptide consists essentially of Ser (69) - Ser (208) of SEQ ID NO:2.

5 64. The method of claim 63, having a Met residue at the N-terminus.

65. The method of claim 51, wherein said polypeptide consists of Ser (69) - Ser (208) of SEQ ID NO:2.

66. The method of claim 51, wherein said polypeptide consists of Met (1) - Ser (141) of SEQ ID NO:96.

10 67. The method of claim 1, wherein said polypeptide is (b).

68. The method of claim 67, wherein said substitution is selected from the group consisting of: Arg (80) Lys, Lys (87) Arg, Tyr (88) Trp, Phe (89) Tyr, Lys (91) Arg, Ser (99) Lys, Lys (102) Gln, Lys 103(Glu), Glu (104) Met, Asn (105) Lys, Pro (107) Asn, Ser (109) Asn, Leu (111) Met, Thr (114) Arg, Glu(117) Ala, Val (120) Ile, Val (123) Ile, Ala (125) Gly, Ile (126) Val, Asn (127) Glu, Asn (127) Gln, Tyr (130) Phe, Met (134) Thr, Lys (136) Glu, Lys (137) Glu, Gly (142) Ala, Ser (143) Lys, Phe (146) Ser, Asn (148) Glu, Lys (151) Asn, Leu (152) Phe, Glu (154) Gly, Glu (154) Asp, Arg (155) Leu, Glu (157) Leu, Gly (160) His, Phe (167) Ala, Asn (168) Lys, Gln (170) Thr, Arg (174) Gly, Tyr (177) Phe, Gly (182) Gln, Ala (185) Val, Ala (185) Leu, Ala (185) Ile, Arg (187) Gln (190) Lys, Lys (195) Glu, Thr (197) Lys, Ser (198) Thr, Arg (194) Glu, Arg (194) Gln, Lys (191) Glu, Lys (191) Gln, Arg (188) Glu, Arg (188) Gln, and Lys (183) Glu.

15

20

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1 ATGTGGAATGGATACTGACACATTGTGCCTCAGCCTTTCCCCACCTGCCCGGCTGCTGC
-----+-----+-----+-----+-----+-----+
TACACCTTTACCTATGACTGTGTAACACGGAGTCGAAAGGGGTGGACGGGCCGACGACG 60
M W K W I L T H C A S A F P H L P G C C

61 TGCTGCTGCTTTTGTGCTGTTCTTGGTGTCTCCGTCCCTGTCACCTGCCAAGCCCTT
-----+-----+-----+-----+-----+-----+
ACGACGACGAAAAACAACGACAAGAACCACAGAAGGCAGGGACAGTGGACGGTTCGGGAA 120
C C C F L L L F L V S S V P V T C Q A L

121 GGTCAGGACATGGTGTCAACAGAGGCCACCAACTCTTCTCCTCCTCTCCTCTCCT
-----+-----+-----+-----+-----+-----+
CCAGTCCTGTACCACAGTGGTCTCCGGTGGTTGAGAAGAAGGAGGAGGAAGAGGAGAGGA 180
G Q D M V S P E A T N S S S S S F S S P

181 TCCAGCGCGGGAAGGCATGTgCGGAGCTACAATCACCTTCAAGGAGATGTCCGCTGGAGA
-----+-----+-----+-----+-----+-----+
AGGTGCGGCCCTTCCGTACAcGCCTCGATGTTAGTGGAAGTTCCTCTACAGGCGACCTCT 240
S S A G R H V R S Y N H L Q G D V R W R

MATCH WITH FIG. 1B

FIG.1A

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MATCH WITH FIG. 1A

241 AAGCTATTCTCTTTCACCAAGTACTTTCTCAAGATTGAGAAGAACGGGAAGGTCAGCGGG 300
-----+-----+-----+-----+-----+-----+
TTCGATAAGAGAAAGTGGTTCATGAAAGAGTTCTAACTCTTCTTGGCCTTCCAGTCGCCC

K L F S F T K Y F L K I E K N G K V S G

301 ACCAAGAAGGAGAACTGCCGTACAGCATCCTGGAGATAACATCAGTAGAAATCGGAGTT 360
-----+-----+-----+-----+-----+-----+
TGGTTCCTCCTTTCGCGGCATGTCGTAGGACCTCTATTGTAGTCATCTTTAGCCTCAA

T K K E N C P Y S I L E I T S V E I G⁻V
-
361 GTTGCCGTCAAAGCCATTAACAGCAACTATTACTTAGCCATGAACAAGAAGGGGAAACTC 420
-----+-----+-----+-----+-----+-----+
CAACGGCAGTTTCGGTAATTGTCGTTGATAATGAATCGGTACTTGTTCTTCCCCTTTGAG

V A V K A I N S N Y Y L A M N K K G K L

421 TATGGCTCAAAAGAATTTAACAATGACTGTAAGCTGAAGGAGAGGATAGAGGAAAATGGA 480
-----+-----+-----+-----+-----+-----+
ATACCGAGTTTCTTAAATTGTTACTGACATTCGACTTCCTCTCCTATCTCCTTTTACCT

Y G S K E F N N D C K L K E R I E E N G

MATCH WITH FIG. 1C

FIG.1B

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MATCH WITH FIG. 1B

481 TACAATACCTATGCATCATTTAACTGGCAGCATAATGGGAGGCAAATGTATGTGGCATTG 540
-----+-----+-----+-----+-----+-----+
ATGTTATGGATACGTAGTAAATTGACCGTCGTATTACCCTCCGTTTACATACACCGTAAC

Y N T Y A S F N W Q H N G R Q M Y V A L

AATGGAAAAGGAGCTCCAAGGAGAGGACAGAAAACACGAAGGAAAAACACCTCTGCTCAC
541 -----+-----+-----+-----+-----+-----+ 600
TTACCTTTTCCTCGAGGTTCTCTCCTGTCTTTGTGCTTCCTTTTGTGGAGACGAGTG

N G K G A P R R G Q K T R R K N T S A H

TTTCTTCCAATGGTGGTACACTCATAG
601 -----+-----+----- 627
AAAGAAGGTTACCACCATGTGAGTATC

F L P M V V H S *

FIG.1C

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	1		50
FGF4	MS.GPGTAAV ALLPAVLLAL LA.....	.PWAGRGGAA APTAPNGTLE	
FGF6	MSRGAGRLQG TLWALVFLGI LV.....	.GMVVPSPAG TR.ANNTLLD	
FGF5	.....MSL SFLLLFFSH LILSAWAHGE	KRLAPKGQPG PAATDRNPIG	
FGF1	.....	.....
FGF2	.....	.....
FGF9	.....	..MAPLGEVG NYFGVQDAVP	
FGF7	.....MHKW ILTWILPTLL	YRSCF HIICLVGTIS	
KGF2	.....MWKW ILTHCASAFA	HLPGCCCCCF LLLFLVSSVP	
FGF3	.....	.....MGL IWLLLLSLE	
FGF8	MGSPRSALSC LLLHLLVLCL QAQVRSAAQK	RGPGAGNPAD TLGQGHEDRP	

	51		100
FGF4	AELERRWESL VALSLARLPV AA..QPKEAA	VQSGAGDY.. ...LLGIKRL	
FGF6	S...RGWGT LSRSRAGLAG EI.....AG	VNWESG.Y.. ...LVGIKRO	
FGF5	SSSRQSSSA MSSSSASSP AASLGSQSG	LEQSSFQW.. ...SPSGRRT	
FGF1	.....MAEG EITTFALTE KFN...LPPG	.....N.. ...YK...KP	
FGF2	.....MAAG SITTLPALPE DGGSGAFPPG	.....H.. ...FK...DP	
FGF9	FGNVPVLPVD SPVLLSDHLG QSEAGGLPRG	PAVTDLDH.. ...LKGILRR	
FGF7	LACNDMTPEQ M...ATNVNC	SSPE RHTRSYDY.. ...MEGGDIR	
KGF2	VTCQALGQDM VSPEATNSSS SSFSSPSSAG	RHVRSYNH.. ...LQ.GDVR	
FGF3	PGWPAAGPGA .....	...RLRRDAG GRGGVYEH.. ...L.GGAPR	
FGF8	FGQSRAGKN FTNPAPNYPE EGSKEQDSV	LPKVTQRHVR EQSLVTDQLS	

MATCH WITH FIG. 2B

FIG. 2A

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MATCH WITH FIG. 2A

	101		150
FGF4	RRL.....YC	NVGIGFHLQA	LPDGRIGGAH ADT.RDSLLE LSPVERGV.V
FGF6	RRL.....YC	NVGIGFHLQV	LPDGRISGTH EEN.PYSLLE ISTVERGV.V
FGF5	GSL.....YC	RVGIGFHLQI	YPDGKVNGSH EAN.MLSVLE IFAVSQGI.V
FGF1	KLL.....YC	SNG.GHFLRI	LPDGTVDGTR DRSDQHIQLQ LSAESVGE.V
FGF2	KRL.....YC	KNG.GFFLRI	HPDGRVDGVR EKSDPHIKLQ LQAEERGV.V
FGF9	RQL.....YC	R.T.GFHLEI	FPNGTIQGTR KDHSRFGILE FISIAVGL.V
FGF7	VRR.....LF	CRT.QWYLRI	DKRGKVKGTQ EMKNNYNIME IRTVAVGI.V
KGF2	WRK.....LF	SFT.KYFLKI	EKNGKVSQTK KENCPSYILE ITSVEIGV.V
FGF3	RRK.....LY	CAT.KYHLQL	HPSGRVNGSL .ENSAYSILE ITAVEVGI.V
FGF8	RRLIRTYQLY	SRTSGKHVQV	LANKRINAMA EDGDPFAKLI VETDTFGSRV

	151		200
FGF4	SIFGVASRFF	VAMSSKGKLY	G.SPFFTDEC TFKEILLPNN YNAYESYKYP
FGF6	SLFGVRSALF	VAMNSKGRLY	A.TPSFQEEC KFRETLLPNN YNAYESDLYQ
FGF5	GIRGVFSNKF	LAMSKKGKLY	A.SAKFTDDC KFRERFQENS YNTYASAIHR
FGF1	YIKSTETGQY	LAMDTDGLLY	G.SQTPNEEC LFLERLEENH YNTYISKKH.
FGF2	SIKGVCANRY	LAMKEDGRLL	A.SKCVTDEC FFERLESNN YNTYRSRKY.
FGF9	SIRGVDSGLY	LGMNEKGELY	G.SEKLTQEC VFREQFEENW YNTYSSNLYK
FGF7	AIKGVSESEFY	LAMNKEGKLY	A.KKECNEDC NFKELILENH YNTYAS....
KGF2	AVKAINSNIYY	LAMNKKGKLY	G.SKEFNNDK KLKERIEENG YNTYAS....
FGF3	AIRGLFSGRY	LAMNKRGRLY	A.SEHYSAEC EFVERIHELG YNTYASRLYR
FGF8	RVRGAETGLY	ICMNNKGKLY	AKSNGKGKDC VFTEIVLENN YTALQNAKY.

MATCH WITH FIG. 2C

FIG. 2B

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MATCH WITH FIG. 2B

	201	250
FGF4 GM..... FI	ALSKNGKTKK G..NRVSPTM KVTHFLPRL.
FGF6 GT..... YI	ALSKYGRVKR G..SKVSPIM TVTHFLPRI.
FGF5	..... TEKTGREWYV	ALNKRKGAKR GCSPRVKPQH ISTHFLPRFK
FGF1	..... ..AEKNWFV	GLKKNGSCKR G..PRTHYGQ KAILFLPLPV
FGF2	..... ..T..SWYV	ALKRTGQYKL G..SKTGPGQ KAILFLPMSA
FGF9	HV..... ..DTGRRYYV	ALNKDGTPRE G..TRTKRHQ KFTHFLPRPV
FGF7	..... AKW THNGGEM.FV	ALNQKGIPVR G..KKTKKEQ KTAHFLPMAI
KGF2	..... FNW QHNGRQM.YV	ALNGKGAPRR G..QKTRRKN TSAHFLPMV
FGF3	TVSSTPGARR QPSAERLWYV	SVNGKGRPRR G..FKTRRTQ KSSLFLPRVL
FGF8	..... ..EGWYM	AFTRKGRPRK G..SKTRQH Q REVHFMKRLP

	251	300
FGF4	.....	.....
FGF6	.....	.....
FGF5	QSEQPELSFT VTVPEKKNPP	SPIKSKIPLS APRKNTNSVK YRLKFRFG..
FGF1	SSD.....	.....
FGF2	KS.....	.....
FGF9	DPDKVPELYK DILSQS....	.....
FGF7	T.....	.....
KGF2	HS.....	.....
FGF3	DHRDHEMVRQ LQSGLP RPPG	KGVP RRRRQ KQSPDNLEPS HVQASRLGSQ
FGF8	RGHHTTEQSL RFEFLNYPFF	TRSLRGSQRT WAPEPR....

MATCH WITH FIG. 2D

FIG. 2C

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MATCH WITH FIG. 2C

	301
FGF4
FGF6
FGF5
FGF1
FGF2
FGF9
FGF7
KGF2
FGF3	LEASAH
FGF8

FIG.2D

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GGAATTCCGG GAAGAGAGGG AAGAAAACAA CGGCGACTGG GCAGCTGCCT CCACTTCTGA	60
CAACTCCAAA GGGATATACT TGTAGAAGTG GCTCGCAGGC TGGGGCTCCG CAGAGAGAGA	120
CCAGAAGGTG CCAACCGCAG AGGGGTGCAG ATATCTCCCC CTATTCCCCA CCCCACCTCC	180
CTTGGGTTTT GTTCACCGTG CTGTCATCTG TTTTTCAGAC CTTTTTGGCA TCTAACATGG	240
TGAAGAAAGG AGTAAAGAAG AGAACAAGT AACTCCTGGG GGAGCGAAGA GCGCTGGTGA	300
CCAACACCAC CAACGCCACC ACCAGCTCCT GCTGCTGCGG CCACCCACGT CCACCATTTA	360
CCGGGAGGCT CCAGAGCGGT AGGCAGCGGA TCCGAGAAAG GAGCGAGGGG AGTCAGCCGG	420
CTTTTCCGAG GAGTTATGGA TGTGGTGCA TTTACTTCTG GCCAGATCCG CGCCAGAGG	480
GAGCTAACCA GCAGCCACCA CCTCGAGCTC TCTCCTTGCC TTGCATCGGG TCTTACCCTT	540
CCAGTATGTT CTTCTGATG AGACAATTC CAGTGCCGAG AGTTTCAGTA CA ATG	595
Met	
TGG AAA TGG ATA CTG ACA CAT TGT GCC TCA GCC TTT CCC CAC CTG CCC	643
Trp Lys Trp Ile Leu Thr His Cys Ala Ser Ala Phe Pro His Leu Pro	
GGC TGC TGC TGC TGC TGC TTT TTG TTG CTG TTC TTG GTG TCT TCC GTC	691
Gly Cys Cys Cys Cys Cys Phe Leu Leu Leu Phe Leu Val Ser Ser Val	
CCT GTC ACC TGC CAA GCC CTT GGT CAG GAC ATG GTG TCA CCA GAG GCC	739
Pro Val Thr Cys Gln Ala Leu Gly Gln Asp Met Val Ser Pro Glu Ala	
ACC AAC TCT TCT TCC TCC TCC TTC TCC TCT CCT TCC AGC GCG GGA AGG	787
Thr Asn Ser Ser Ser Ser Ser Phe Ser Ser Pro Ser Ser Ala Gly Arg	
CAT GTG CGG AGC TAC AAT CAC CTT CAA GGA GAT GTC CGC TGG AGA AAG	835
His Val Arg Ser Tyr Asn His Leu Gln Gly Asp Val Arg Trp Arg Lys	
CTA TTC TCT TTC ACC AAG TAC TTT CTC AAG ATT GAG AAG AAC GGG AAG	883
Leu Phe Ser Phe Thr Lys Tyr Phe Leu Lys Ile Glu Lys Asn Gly Lys	
GTC AGC GGG ACC AAG AAG GAG AAC TGC CCG TAC AGC ATC CTG GAG ATA	931
Val Ser Gly Thr Lys Lys Glu Asn Cys Pro Tyr Ser Ile Leu Glu Ile	
ACA TCA GTA GAA ATC GGA GTT GTT GCC GTC AAA GCC ATT AAC AGC AAC	979
Thr Ser Val Glu Ile Gly Val Val Ala Val Lys Ala Ile Asn Ser Asn	
TAT TAC TTA GCC ATG AAC AAG AAG GGG AAA CTC TAT GGC TCA AAA GAA	1027
Tyr Tyr Leu Ala Met Asn Lys Lys Gly Lys Leu Tyr Gly Ser Lys Glu	
TTT AAC AAT GAC TGT AAG CTG AAG GAG AGG ATA GAG GAA AAT GGA TAC	1075
Phe Asn Asn Asp Cys Lys Leu Lys Glu Arg Ile Glu Glu Asn Gly Tyr	

FIG.3A

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AAT ACC TAT GCA TCA TTT AAC TGG CAG CAT AAT GGG AGG CAA ATG TAT Asn Thr Tyr Ala Ser Phe Asn Trp Gln His Asn Gly Arg Gln Met Tyr	1123
GTG GCA TTG AAT GGA AAA GGA GCT CCA AGG AGA GGA CAG AAA ACA CGA Val Ala Leu Asn Gly Lys Gly Ala Pro Arg Arg Gly Gln Lys Thr Arg	1171
AGG AAA AAC ACC TCT GCT CAC TTT CTT CCA ATG GTG GTA CAC TCA Arg Lys Asn Thr Ser Ala His Phe Leu Pro Met Val Val His Ser	1216
TAGAGGAAGG CAACGTTTGT GGATGCAGTA AAACCAATGG CTCTTTTGCC AAGAATAGTG	1276
GATATTCTTC ATGAAGACAG TAGATTGAAA GGCAAAGACA CGTTGCAGAT GTCTGCTTGC	1336
TTAAAAGAAA GCCAGCCTTT GAAGGTTTTT GTATTCAC TGACATATG ATGTTCTTTT	1396
AATTAGTTCT GTGTCATGTC TTATAATCAA GATATAGGCA GATCGAATGG GATAGAAGTT	1456
ATTCCAAGT GAAAAACATT GTGGCTGGGT TTTTGTGTGT TGTGTCAAG TTTTGTTTT	1516
TAAACCTCTG AGATAGAACT TAAAGGACAT AGAACAATCT GTTGAAAGAA CGATCTTCGG	1576
GAAAGTTATT TATGGAATAC GAACTCATAT CAAAGACTTC ATTGCTCATT CAAGCCTAAT	1636
GAATCAATGA ACAGTAATAC GTGCAAGCAT TACTGGAAA GCACTTGGGT CATATCATAT	1696
GCACAACCAA AGGAGTTCTG GATGTGGTCT CATGGAATAA TTGAATAGAA TTTAAAAATA	1756
TAAACATGTT AGTGTGAAAC TGTCTAACA ATACAAATAG TATGGTATGC TTGTGCATTC	1816
TGCCTTCATC CCTTTCTATT TCTTTCTAAG TTATTTATTT AATAGGATGT TAAATATCTT	1876
TTGGGGTTTT AAAGAGTATC TCAGCAGCTG TCTTCTGATT TATCTTTTCT TTTTATTCAG	1936
CACACCACAT GCATGTTTAC GACAAAGTGT TTTTAAAACT TGGCGAACAC TTCAAAAATA	1996
GGAGTTGGGA TTAGGGAAGC AGTATGAGTG CCCGTGTGCT ATCAGTTGAC TTAATTTGCA	2056
CTTCTGCAGT AATAACCATC AACAATAAAT ATGGCAATGC TGTGCCATGG CTTGAGTGAG	2116
AGATGTCTGC TATCATTTGA AACATATAT TACTCTCGAG GCTTCCTGTC TCAAGAAATA	2176
GACCAGAAGG CCAAATTCTT CTCTTTCAAT ACATCAGTTT GCCTCCAAGA ATATACTAAA	2236
AAAAGGAAAA TTAATTGCTA AATACATTTA AATAGCCTAG CCTCATTATT TACTCATGAT	2296
TTCTTGCCAA ATGTCATGGC GGTAAGAGG CTGTCCACAT CTCTAAAAAC CCTCTGTAAA	2356
TTCCACATAA TGCATCTTTC CCAAAGGAAC TATAAGAAT TTGGTATGAA GCGCAACTCT	2416

FIG.3B

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CCCAGGGGCT TAAACTGAGC AAATCAAATA TATACTGGTA TATGTGTAAC CATATACAAA	2476
AACCTGTTCT AGCTGTATGA TCTAGTCTTT AAAAAACCAA ATAAACTTG TTTTCTGTAA	2536
ATTAAAGAG CTTTACAAGG TTCCATAATG TAACCATATC AAAATTCATT TTGTTAGAGC	2596
ACGTATAGAA AAGAGTACAT AAGAGTTTAC CAATCATCAT CACATTGTAT TCCACTAAAT	2656
AAATACATAA GCCTTATTTG CAGTGTCTGT AGTGATTTTA AAAATGTAGA AAAATACTAT	2716
TTGTTCTAAA TACTTTTAAG CAATACTAT AATAGTATAT TGATGCTGCA GTTTTATCTT	2776
CATATTTCTT GTTTTGAAAA AGCATTTTAT TGTGTTGACA CAGTATTTTG GTACAAAAAA	2836
AAAGACTCAC TAAATGTGTC TTAATAAGT TTAACCTTTG GAAATGCTGG CGTTCTGTGA	2896
TTCTCCAACA AACTTATTTG TGTCAATACT TAACCAGCAC TTCCAGTTAA TCTGTTATTT	2956
TTAAAAATTG CTTTATTAAG AAATTTTTTG TATAATCCCA TAAAGGTCA TATTTTCCC	3016
ATTCTTCAAA AAAACTGTAT TTCAGAAGAA ACACATTTGA GGCAGTGTCT TTTGGCTTAT	3076
AGTTTAAATT GCATTTTATC ATACTTTGCT TCCAAGTGC TTTTGGCAA ATGAGATTAT	3136
AAAAATGTTT AATTTTTGTG GTTGAATCT GGATGTAAA ATTTAATTGG TAACTCAGTC	3196
TGTGAGCTAT AATGTAATGC ATTCCTATCC AACTAGGTA TCTTTTTTTC CTTTATGTTG	3256
AAATAATAAT GGCACCTGAC ACATAGACAT AGACCACCCA CAACCTAAAT TAAATGTTTG	3316
GTAAGACAAA TACACATTGG ATGACCACAG TAACAGCAAA CAGGGCACAA ACTGGATTCT	3376
TATTTACAT AGACATTTAG ATTACTAAAG AGGGCTATGT GTAAACAGTC ATCATTATAG	3436
TACTCAAGAC ACTAAACAG CTCTAGCCA AATATATTAA AGCTTGCAGA GGCCAAAAAT	3496
AGAAAACATC TCCCCTGTCT CTCCACATT TCCCTCACAG AAAGACAAAA AACCTGCCTG	3556
GTGCAGTAGC TCACACCTGT AATCCCAGCA GTTTGGGAGA CTGTGGGAAG ATGGCTTGAG	3616
TCCAGGAGTT CTAGACAGGC CTGAGAAACC TAGTGAGACA TCCTTCTCTT AAACAAAACA	3676
AAACAAAACA AATGTAGCCA TGGTGGTGG CATATACCTG TGGTCCCAAC TACTCAGGAG	3736
GCTGAAACGG AAGGATCTCT TGGGCCCCAG GAGTTTGAGG CTGCAGTGAG CTATAATCTT	3796
GCCATTGCAC TCCAGCCTGG GTGAAAAAGA GCCAGAAAGA AAGGAAAGAG AGAAAAGAGA	3856
AAAGAAAGAG AGAAAAGACA GAAAGACAGG AAGGAAGGAA GGAAGGAAGG AAGGAAGGAA	3916
GGAAGCAAGG AAAGAAGGAA GGAAGGAAAG AAGGGAGGGA AGGAAGGAGA GAGAAAGAAA	3976
GATTGTTTGG TAAGGAGTAA TGACATTCTC TTGCATTTAA AAGTGGCATA TTTGCTTGAA	4036

FIG.3C

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ATGGAATAG AATTCTGGTC CCTTTTGCAA CTAAGAAGAAAAAG CAGTTTCAGC 4096
CCTGAATGTT GTAGATTGA AAAAAAAAAA AAAAAAATC GAGGGGGGGC CCGTACCCAA 4156
TTCGCCCTAT AGTGAGTCGT A 4177

FIG.3D

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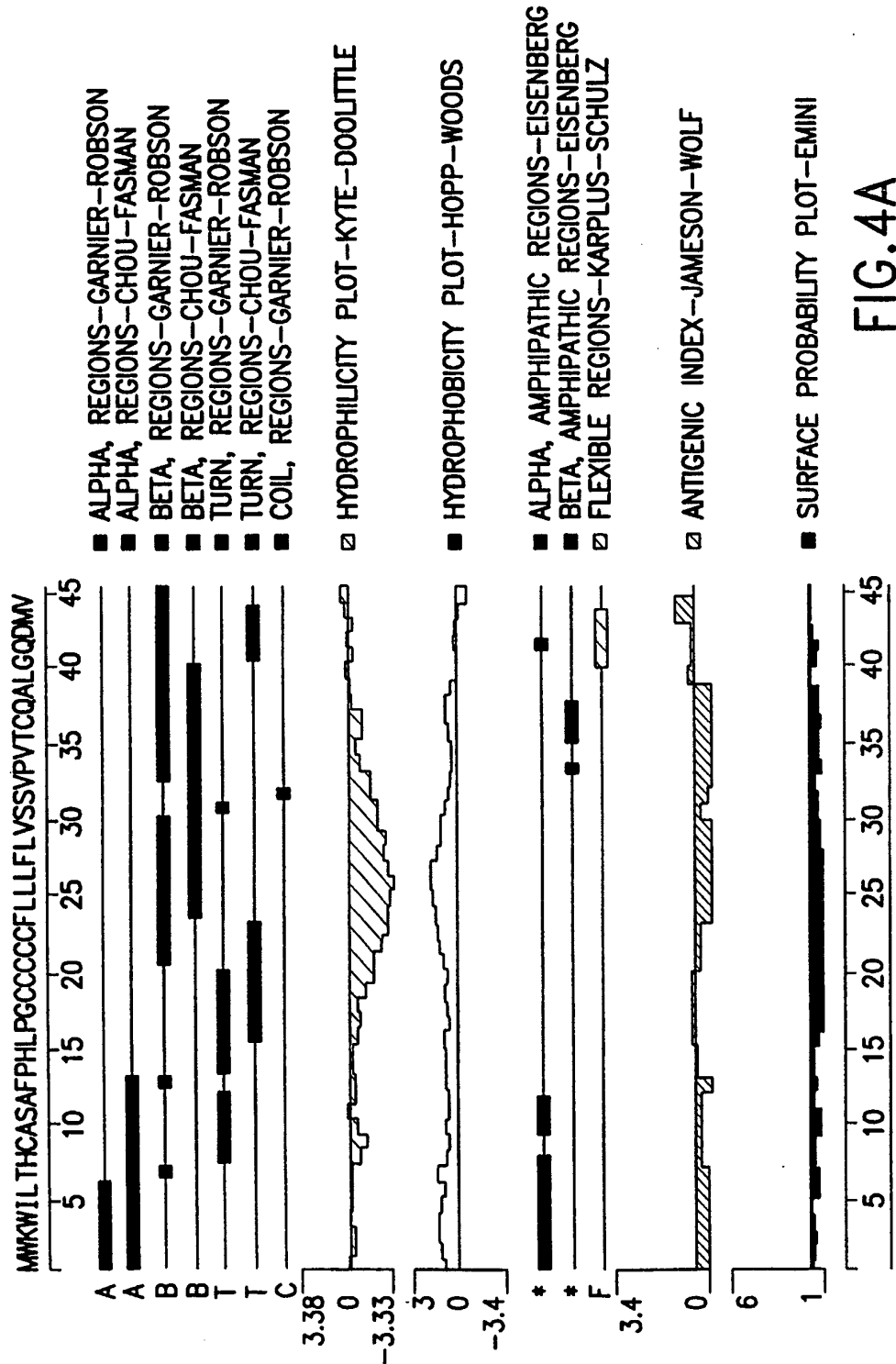
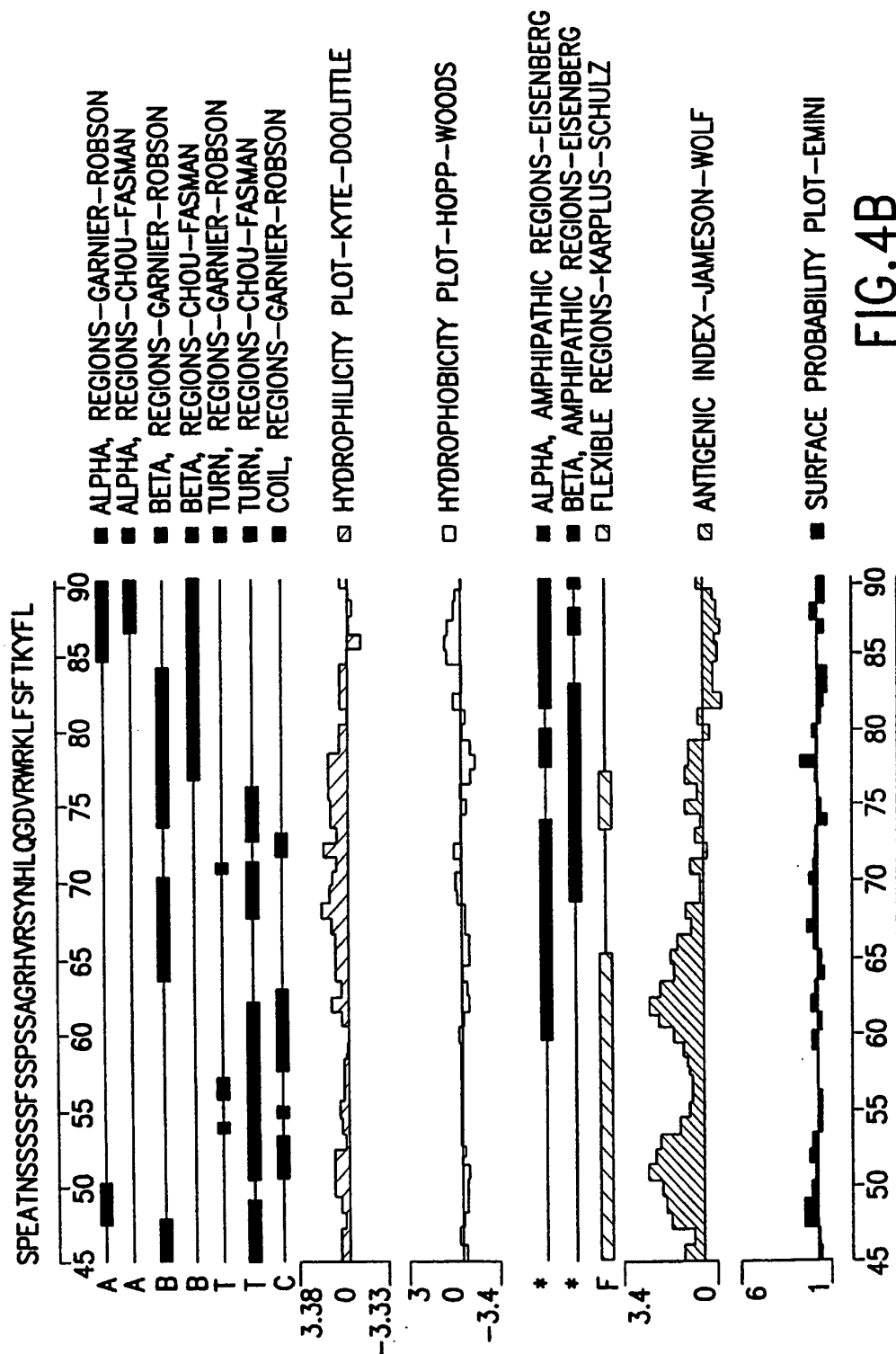
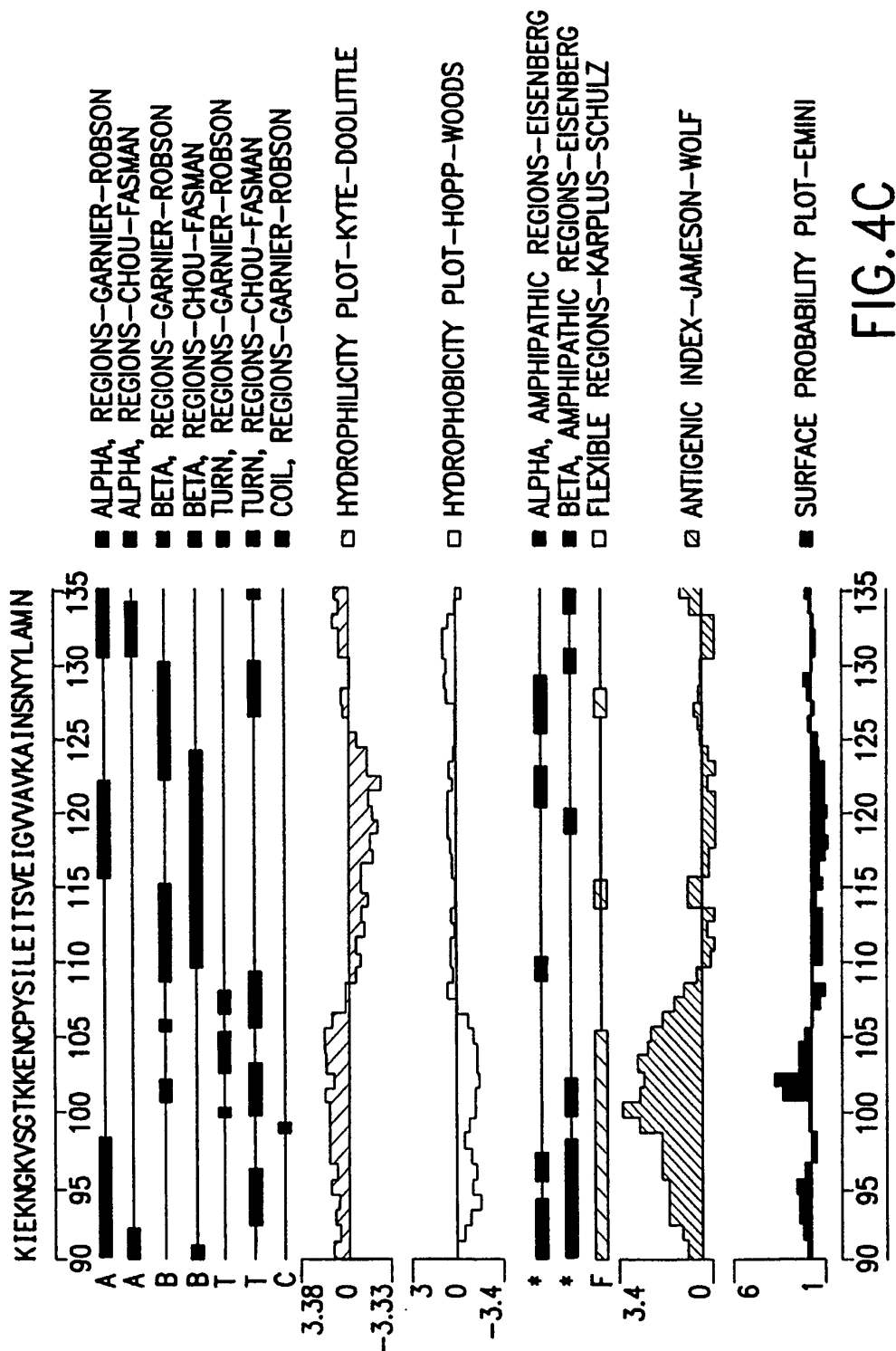


FIG. 4A

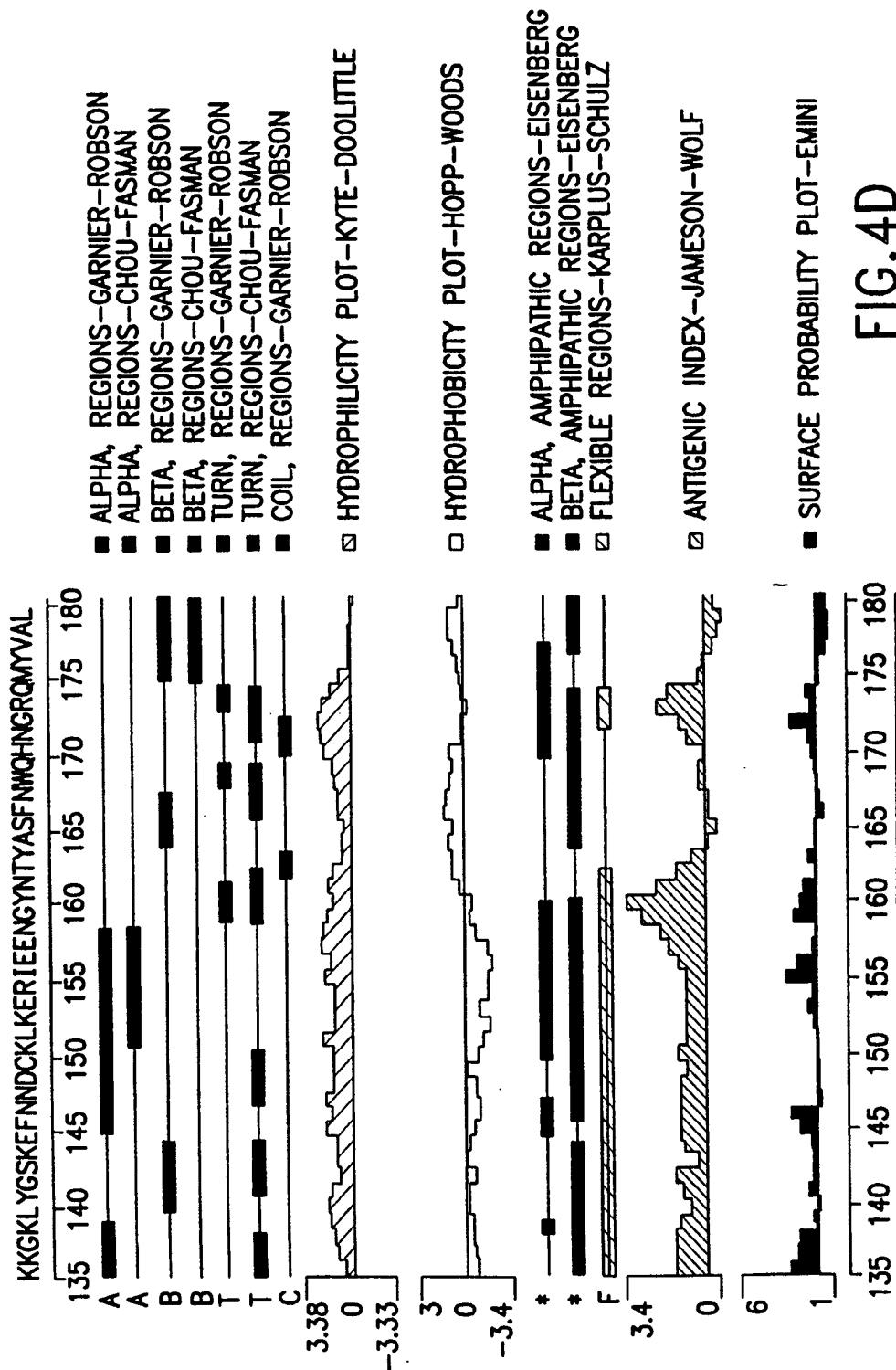
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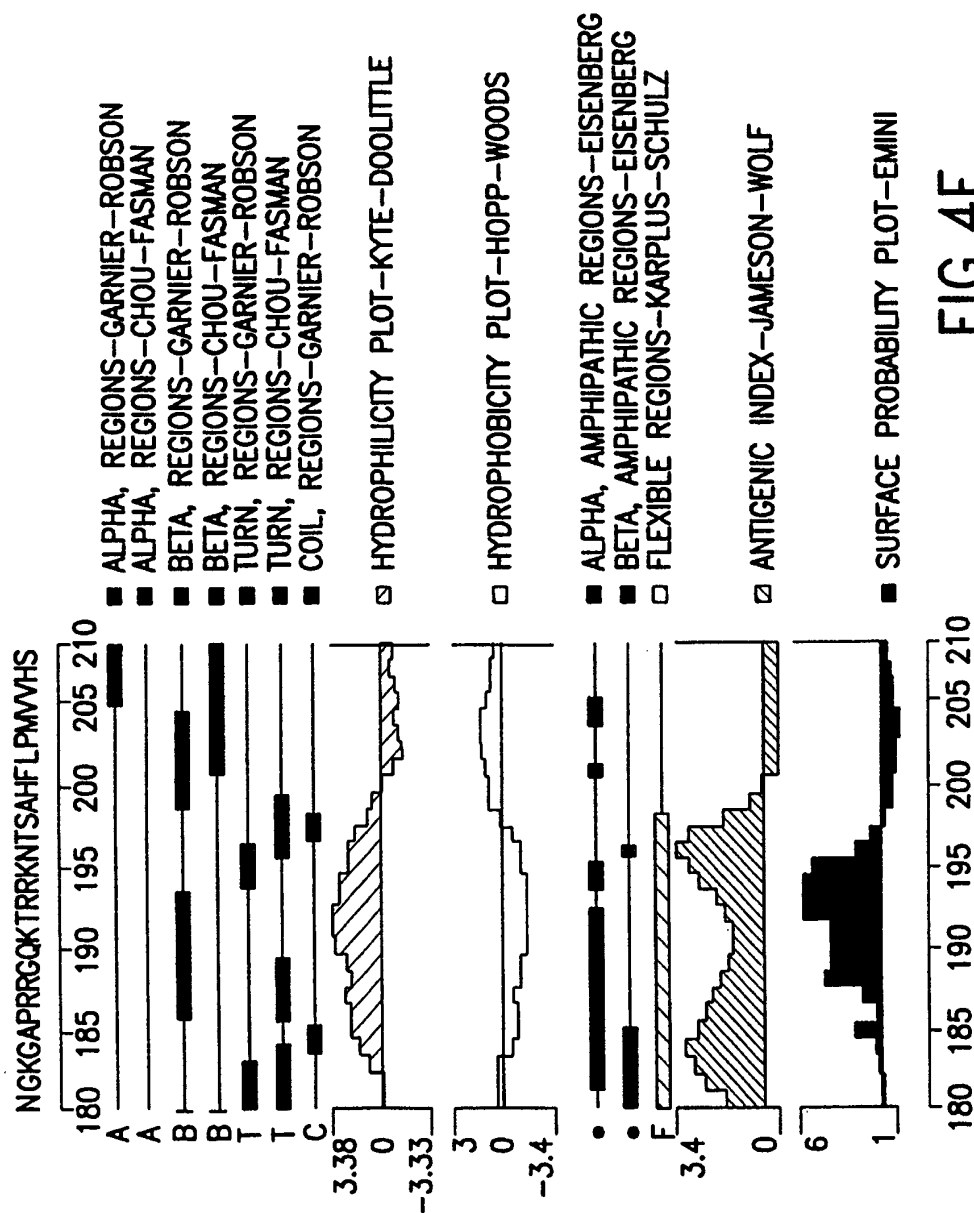
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ATGAGAGGATCGCATCACCATCACCATCACGGATCCTGCCAGGCTCTGGGTC
AGGACATGGTTTCTCGGAAGCTACCAACTCTTCCTCTTCTTTCTTTCCC
CGTCTTCGGCTGGTCGTCAOGTTGTTCTTACAACCACCTGCAGGGTGAOGTTC
GTTGGCGTAAACTGTTCTCTTTCACCAAATACTTCCTGAAAATCGAAAAA
AACGGTAAAGTTTCTGGGACCAAGAAGGAGAACTGCCCGTACAGCATCCTG
GAGATAACATCAGTAGAAATCGGAGTTGTTGCCGTCAAAGCCATTAACAG
CAACTATTACTTAGCCATGAACAAGAAGGGGAACTCTATGGCTCAAAAG
AATTTAACAATGACTGTAAGCTGAAGGAGAGGATAGAGGAAAATGGAT
ACAATACCTATGCATCATTTAACTGGCAGCATAATGGGAGGCAAATGTAT
GTGGCATTGAaTGGAAAAGGAGCTCCAaGGAGAGGACAGAAAACACGAAG
GAAAAACACCTCTGCTCACTTTCTTCCAATGGTGGTACACTCATAG

MRGSHHHHHGSCQALGQDMVSPEATNSSSSSFSSPSSAGRHVRSYNHLQGD
VRWRKLFSTKYFLKIEKNGKVSCTKKENCPSILEITSVEIGVVAVKAINSN
YYLAMNKKGKLYGSKEFNNDCKLKERIEENGYNTYASFNNQHNGRQMYVA
LNGKGAPRRGQKTRRKNTSAHFLPMVVHS

kgf-2 synthetic cys37 Bam HI
AAAGGATCCTGCCAGGCTCTGGGTCAGGACATG

FIG.5

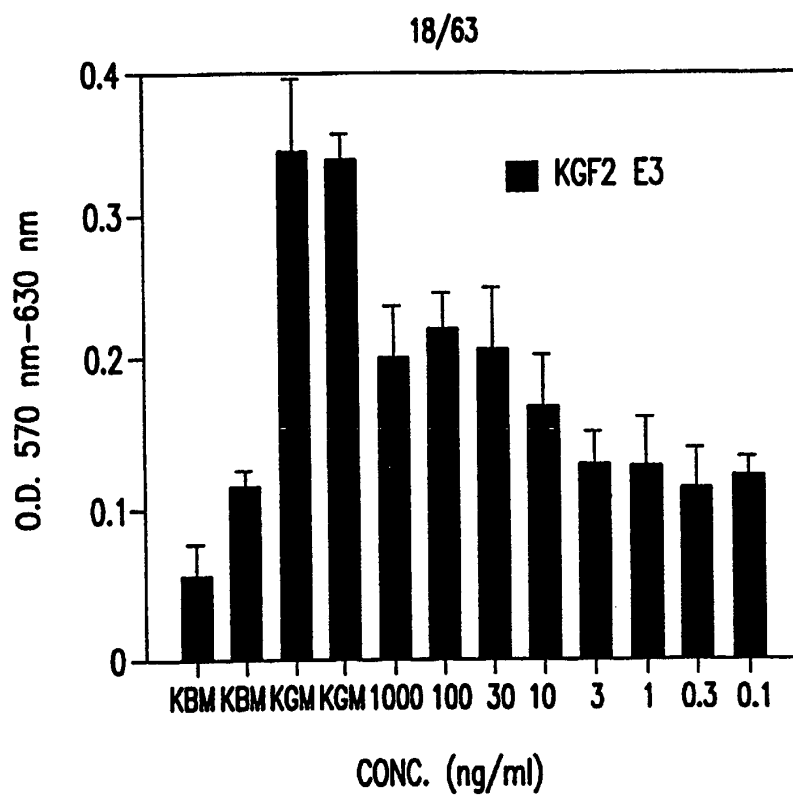


FIG.6A

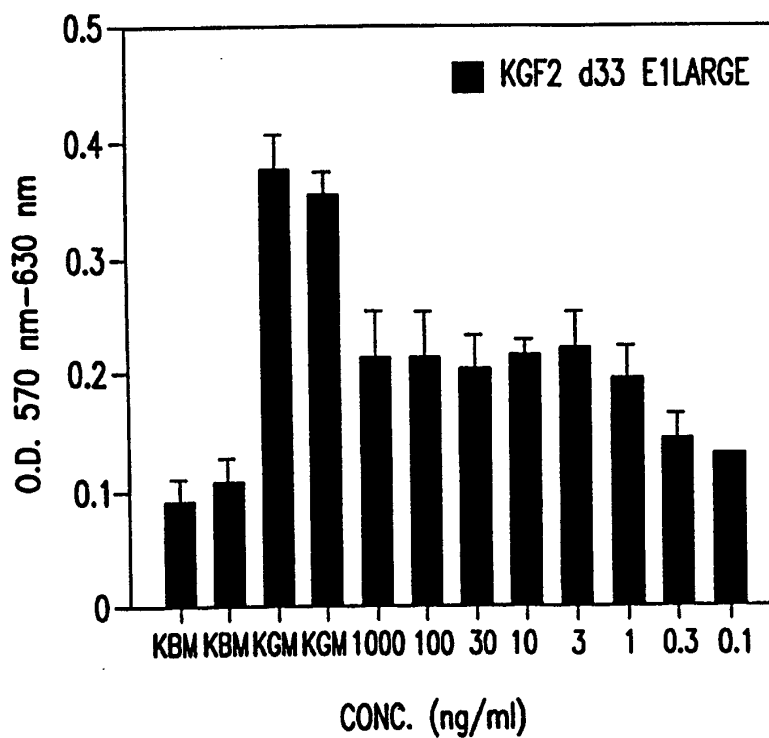


FIG.6B

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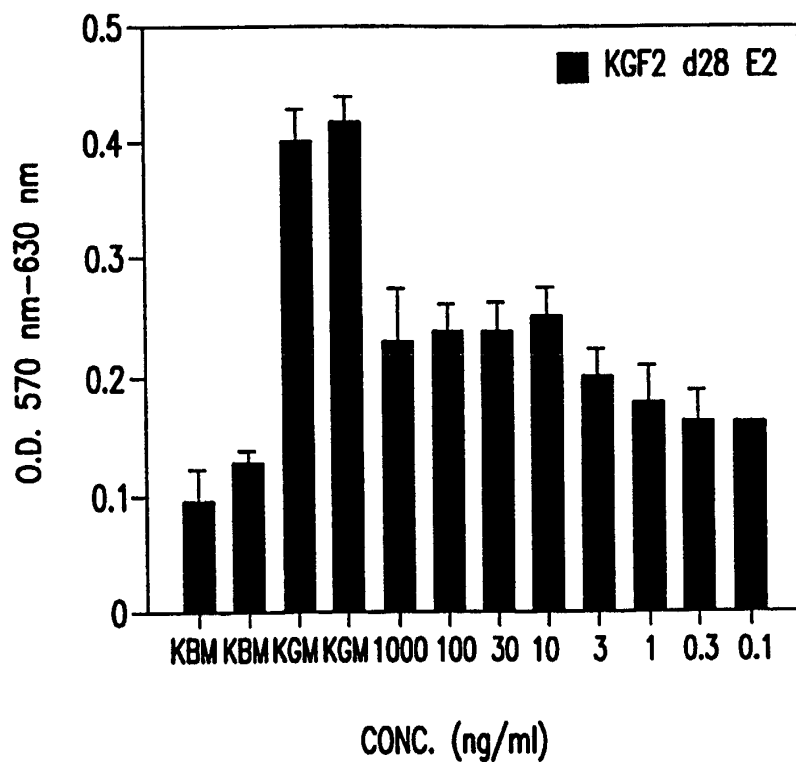


FIG.6C

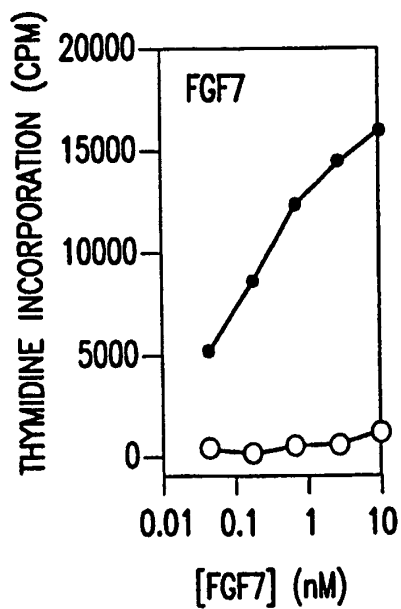


FIG.7A

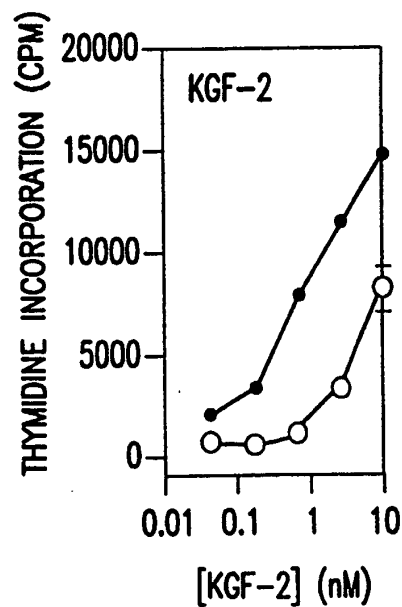


FIG.7A-1

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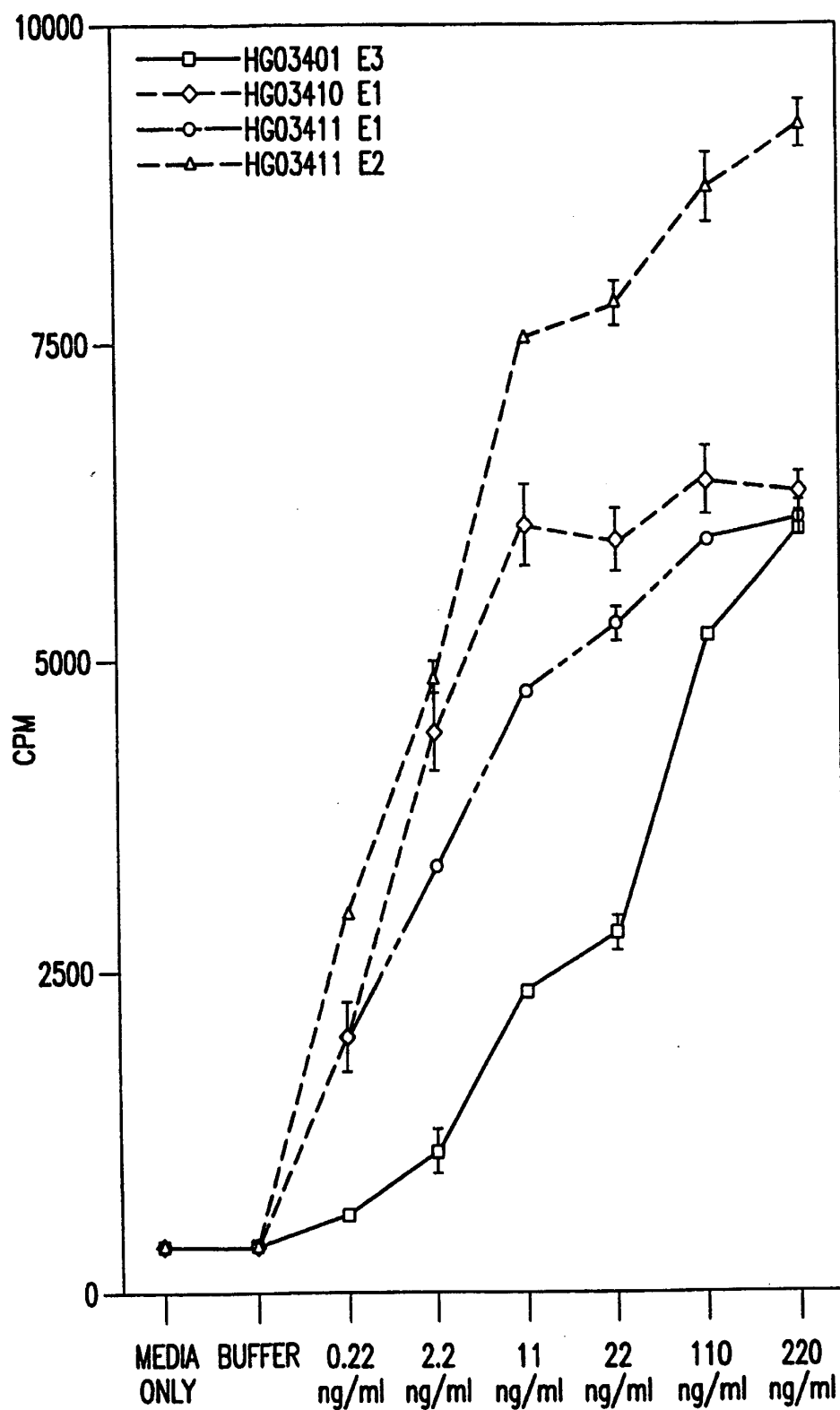


FIG.7B

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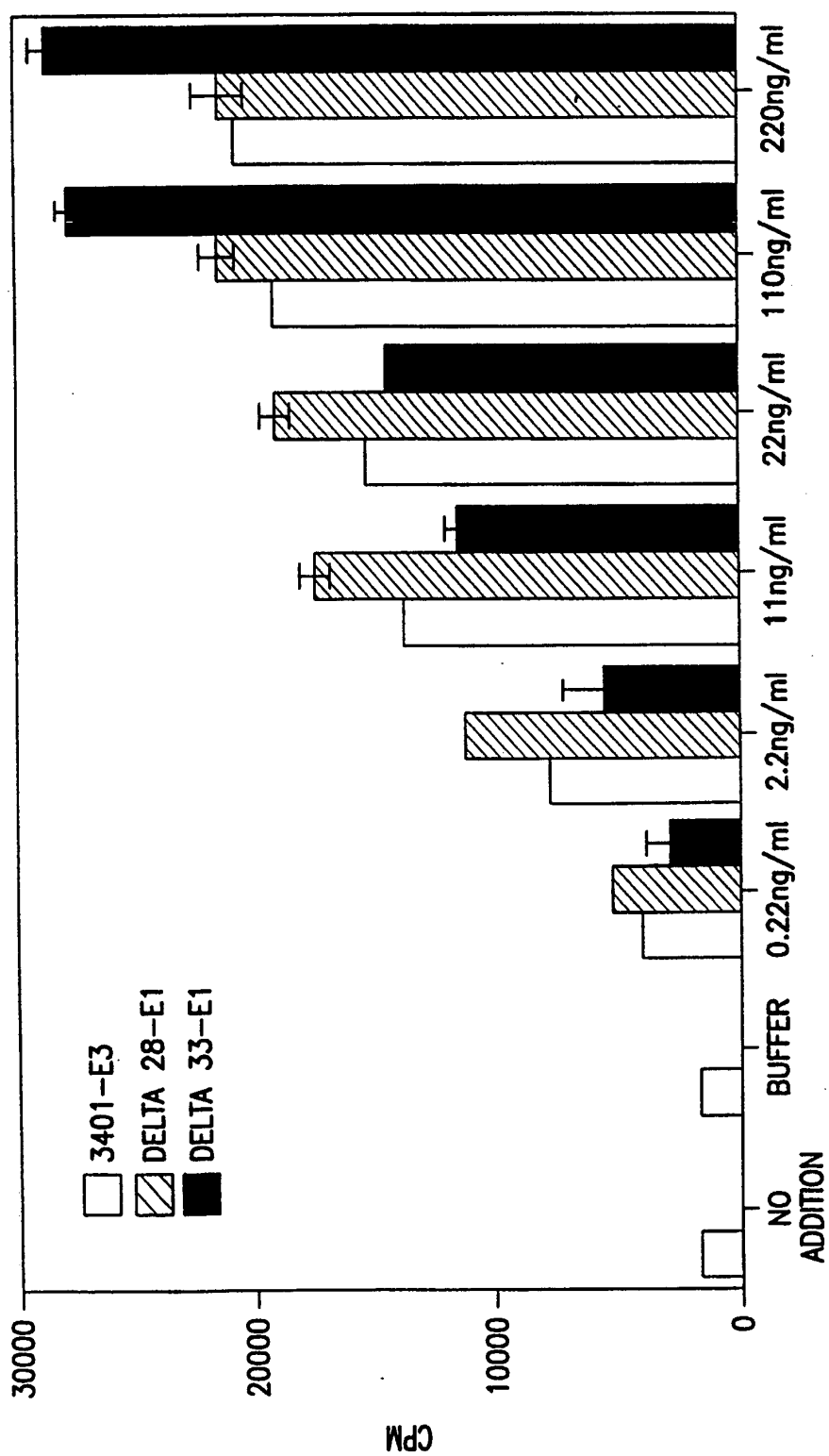


FIG.7C

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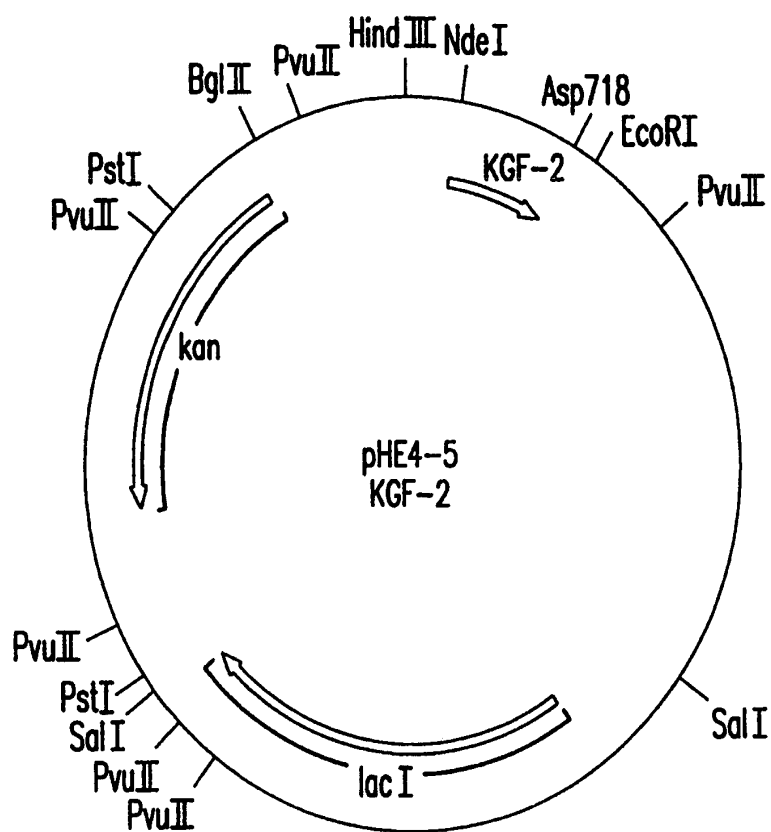


FIG.8

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1 AAGCTTAAAAAAGTCAAAAAATAGTTTGACT(TGTGAGCGGATAAGAAT)
-35 Operator 1
-10 Operator 2
50 TAAGATGTACCCAATTGTGAGCGGATAACAATTTCACACATTAA
S/D
94 AGAGGAGAAATTA CATATG

FIG.9

ATGTGGAATGGATACTGACCCACTGCGCTTCTGCTTTCCCGCACCTGCCGGGTTCGCTGC 60
Met Trp Lys Trp Ile Leu Thr His Cys Ala Ser Ala Phe Pro His Leu Pro Gly Cys Cys

TGCTGCTGCTTCCTGCTGCTGTTCTTGTTCTTCTGTTCCGGTTACCTGCCAGGCTCTG 120
Cys Cys Cys Phe Leu Leu Leu Phe Leu Val Ser Ser Val Pro Val Thr Cys Gln Ala Leu

GGTCAGGACATGGTTTCTCCGGAAGCTACCAACTCTTCCTCTTCCTCTTTCTCTTCCCCG 180
Gly Gln Asp Met Val Ser Pro Glu Ala Thr Asn Ser Ser Ser Ser Ser Phe Ser Ser Pro

ACTTCOGCTGGTCGTCACGTTCTTACAACCACCTGCAGGGTGACGTTTCGTTGGCGT 240
Thr Ser Ala Gly Arg His Val Arg Ser Tyr Asn His Leu Gln Gly Asp Val Arg Trp Arg

AAACTGTTCTCTTTCACCAAATACTTCCTGAAAATCGAAAAAACGGTAAGTTTCTGGG 300
Lys Leu Phe Ser Phe Thr Lys Tyr Phe Leu Lys Ile Glu Lys Asn Gly Lys Val Ser Gly

ACCAAGAAGGAGAACTGCCCGTACAGCATCCTGGAGATAACATCAGTAGAAATCGGAGTT 360
Thr Lys Lys Glu Asn Cys Pro Tyr Ser Ile Leu Glu Ile Thr Ser Val Glu Ile Gly Val

GTTGCCGTCAAAGCCATTAAACAGCACTATTACTTAGCCATGAACAAGAAGGGGAAACTC 420
Val Ala Val Lys Ala Ile Asn Ser Asn Tyr Tyr Leu Ala Met Asn Lys Lys Gly Lys Leu

TATGGCTCAAAGAATTTAACAATGACTGTAAGCTGAAGGAGAGGATAGAGGAAAATGGA 480
Tyr Gly Ser Lys Glu Phe Asn Asn Asp Cys Lys Leu Lys Glu Arg Ile Glu Glu Asn Gly

TACAATACCTATGCATCATTTAACTGGCAGCATAATGGGAGGCCAAATGTATGTGGCATTG 540
Tyr Asn Thr Tyr Ala Ser Phe Asn Trp Gln His Asn Gly Arg Gln Met Tyr Val Ala Leu

AATGGAAGGAGCTCCAAGGAGAGGACAGAAAACACGAAGGAAAAACACCTCTGCTCAC 600
Asn Gly Lys Gly Ala Pro Arg Arg Gly Gln Lys Thr Arg Arg Lys Asn Thr Ser Ala His

TTTCTTCCAATGGTGGTACACTCATAG 627
Phe Leu Pro Met Val Val His Ser *

FIG. 10

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ATGACCTGCCAGGCTCTGGGTCAGGACATGGTTTCTCCGGAAGCTACCAACTCTTCCTCT 60
MetThrCysGlnAlaLeuGlyGlnAspMetValSerProGluAlaThrAsnSerSerSer

TCCTCTTTCTCTTCCCGTCTTCCGCTGGTCGTCACGTTCTTACAACCACCTGCAG 120
SerSerPheSerSerProSerSerAlaGlyArgHisValArgSerTyrAsnHisLeuGln

GGTGACGTTCTGGCGTAAACTGTTCTTTACCAAATACTTCTGAAAATCGAAAA 180
GlyAspValArgTrpArgLysLeuPheSerPheThrLysTyrPheLeuLysIleGluLys

AACGGTAAAGTTTCTGGGACCAAGAAGGAGAACTGCCCGTACAGCATCCTGGAGATAACA 240
AsnGlyLysValSerGlyThrLysLysGluAsnCysProTyrSerIleLeuGluIleThr

TCAGTAGAAATCGGAGTTGTTGCCGTCAAAGCCATTAACAGCAACTATTACTTAGCCATG 300
SerValGluIleGlyValValAlaValLysAlaIleAsnSerAsnTyrTyrLeuAlaMet

AACAAGAAGGGGAACTCTATGGCTCAAAGAATTTAACAATGACTGTAAGCTGAAGGAG 360
AsnLysLysGlyLysLeuTyrGlySerLysGluPheAsnAsnAspCysLysLeuLysGlu

AGGATAGAGGAAAATGGATACAATACCTATGCATCATTTAACTGGCAGCATAATGGGAGG 420
ArgIleGluGluAsnGlyTyrAsnThrTyrAlaSerPheAsnTrpGlnHisAsnGlyArg

CAATGTATGTGGCATTGAATGGAAAAGGAGCTCAAGGAGAGGACAGAAAACACGAAGG 480
GlnMetTyrValAlaLeuAsnGlyLysGlyAlaProArgArgGlyGlnLysThrArgArg

AAAAACACCTCTGCTCACTTTCTCCAATGGTGGTACACTCATAG 525
LysAsnThrSerAlaHisPheLeuProMetValValHisSer *

FIG.11A

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ATGACTTGCCAGGCACTGGGTCAAGACATGGTTTCCCGGAAGCTACCAACAGCTCCAGCTCTAGCTTCA
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----| 70
TACTGAACGGTCCGTGACCCAGTTCTGTACCAAGGGGCTTCGATGGTTGTGAGGTGAGATCGAAGT
M T C Q A L G Q D M V S P E A T N S S S S S F
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
GCAGCCCATCTAGCGCAGGTGTCACGTTGCTCTTACAACCACTTACAGGGTGATGTTGTTGGCCGAA
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----| 140
CGTCGGGTAGATCGCGTCCAGCAGTGCAAGCGAGAATGTTGGTGAATGTCCCACTACAAGCAACCGGTT
S S P S S A G R H V R S Y N H L Q G D V R W R K
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
ACTGTTGAGCTTTACCAAGTACTTCTGAAAATCGAAAAAAGGTAAGTTTCTGGGACCAAGAAGGAG
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----| 210
TGACAAGTCGAAATGGTTCATGAAGGACTTTTAGCTTTTTTGGCATTTCAAAGACCCCTGGTCTTCTCTC
L F S F T K Y F L K I E K N G K V S G T K K E
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
AACTGCCCGTACAGCATCCTGGAGATAACATCAGTAGAAATCGGAGTTGTTGCGTCAAAGCCATTAA
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----| 280
TTGACGGGCATGTCGTAGGACCTCTATTGTAGTCATCTTTAGCCTCAACAAGGCGAGTTTCGGTAATTGT
N C P Y S I L E I T S V E I G V V A V K A I N
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
GCAACTATTACTTAGCCATGAACAAGAAGGGGAACTCTATGGCTCAAAGAATTTAACAATGACTGTAA
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----| 350
CGTTGATAATGAATCGGTACTGTTCTTCCCTTTGAGATACCGAGTTTCTTAAATTGTTACTGACATT
S N Y Y L A M N K K G K L Y G S K E F N N D C K
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
GCTGAAGGAGAGGATAGAGGAAAATGGATACAATACCTATGCATCATTTAACTGGCAGCATAATGGGAGG
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----| 420
CGACTTCTCTCCTATCTCCTTTTACCTATGTTATGGATACGTAGTAAATTGACCGTCGTATTACCTCC
L K E R I E E N G Y N T Y A S F N W Q H N G R
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
CAAATGTATGTGGCATTGAATCGAAAAGGAGCTCCAAGGAGAGGACAGAAAACGAAGGAAAAACCT
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----| 490
GTTACATACACCGTAACCTTACCTTTTCTCGAGGTTCTCTCCTGTCTTTTGCTTCTTTTGTGGA
Q M Y V A L N G K G A P R R G Q K T R R K N T
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
CTGCTCACTTTCTTCCAATGGGTGACTCATAG
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----| 525
GACGAGTGAAGAAGGTTACCACCATGTGAGTATC
S A H F L P M V V H S
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|

FIG.11B

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ATGACCTGCCAGGCTCTGGGTCAAGGACATGGTTTCTCCGGAAGCTACCAACTCTTCC
TCTTCCTCTTTCTCTTCCCCGCTTCCGCTGGTCGTACGTTTCGTTCTTACAACCAC
CTGCAGGGTGACGTTGTTGGCGTAAACTGTTCTTTTACCAAATACTTCCTGAAA
ATCGAAAAAACGGTAAAGTTTCTGGGACCAAGAAGGAGAACTGCCCGTACAGCATC
CTGGAGATAACATCAGTAGAAATCGGAGTTGTTGCCGTCAAAGCCATTAACAGCAAC
TATTACTTAGCCATGAACAAGAAGGGGAACTCTATGGCTCAAAGAATTTAACAAT
GACTGTAAGCTGAAGGAGAGGATAGAGGAAAATGGATAACAATACCTATGCATCATTT
AACTGGCAGCATAATGGGAGGCAAATGTATGTGGCATTGAATGGAAAAGGAGCTCCA
AGGAGAGGACAGAAAACACGAAGGAAAAACACCTCTGCTCACTTTCTTCCAATGGTG
GTACACTCATAG

MTQALGQDMVSPPEATNSSSSSFSSPSSAGRHVRSYNHLQGDVWRKLFSTKYFLKIE
KNGKVSgtkkENCPYSILEITSVEIGVVAVKAINSnyyLAMNKKGKLYGSKEFNNDCKL
KERIEENGYNTYASFNWQHNGRQMYVALNGKGAPRRGQKTRRKNTSAHFLPMVVHS.

FIG.12

ATGGCTGGTCGTACGTTTCGTTCTTACAACCACCTGCAGGGTGACGTTTCGTTGGCGT
AAACTGTTCTTTTACCAAATACTTCCTGAAAAATCGAAAAAACGGTAAAGTTTCT
GGGACCAAGAAGGAGAACTGCCCGTACAGCATCCTGGAGATAACATCAGTAGAAATC
GGAGTTGTTGCCGTCAAAGCCATTAACAGCAACTATTACTTAGCCATGAACAAGAAG
GGGAAACTCTATGGCTCAAAGAATTTAACAATGACTGTAAGCTGAAGGAGAGGATA
GAGGAAAATGGATAACAATACCTATGCATCATTTAACTGGCAGCATAATGGGAGGCAA
ATGTATGTGGCATTGAATGGAAAAGGAGCTCAAGGAGAGGACAGAAAACACGAAGG
AAAAACACCTCTGCTCACTTTCTTCCAATGGTGGTACACTCATAG

MAGRHVRSYNHLQGDVWRKLFSTKYFLKIEKNGKVSgtkkENCPYSILEITSVEIGV
VAVKAINSnyyLAMNKKGKLYGSKEFNNDCKLKERIEENGYNTYASFNWQHNGRQMYVA
LNGKGAPRRGQKTRRKNTSAHFLPMVVHS.

FIG.13

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ATGGTTCGTTGGCGTAACTGTTCTCTTTCACCAAATACTTCCTGAAAATCGAAAA
AACGGTAAAGTTTCTGGGACCAAGAAGGAGAACTGCCCGTACAGCATCCTGGAGATA
ACATCAGTAGAAATCGGAGTTGTTGCCGTCAAAGCCATTAAACAGCAACTATTACTTA
GCCATGAACAAGAAGGGGAACTCTATGGCTCAAAGAATTTAACAATGACTGTAAG
CTGAAGGAGAGGATAGAGGAAAATGGATACAATACCTATGCATCATTTAACTGGCAG
CATAATGGGAGGCAAATGTATGTGGCATTGAATGGAAAAGGAGCTCAAGGAGAGGA
CAGAAAACACGAAGGAAAAACACCTCTGCTCACTTTCTTCCAATGGTGGTACACTCA
TAG

MVRWRKLFSTKYFLKIEKNGKVSgtKKENCpysILEITSVEIGVVAVKAINSnyyLAM
NKKGKLYGSKEFNNDCKLKERIEENgYNTYASFNWQHNGRQMYVALNGKGAPRRGQKTR
RKNTSAHFLPMVVHS.

FIG.14

ATGGAAAAAACGGTAAAGTTTCTGGGACCAAGAAGGAGAACTGCCCGTACAGCAT
CCTGGAGATAACATCAGTAGAAATCGGAGTTGTTGCCGTCAAAGCCATTAAACAGCA
ACTATTACTTAGCCATGAACAAGAAGGGGAACTCTATGGCTCAAAGAATTTAAC
AATGACTGTAAGCTGAAGGAGAGGATAGAGGAAAATGGATACAATACCTATGCATC
ATTTAACTGGCAGCATAATGGGAGGCAAATGTATGTGGCATTGAATGGAAAAGGAG
CTCCAAGGAGAGGACAGAAAACACGAAGGAAAAACACCTCTGCTCACTTTCTTCCA
ATGGTGGTACACTCATAG

MEKNGKVSgtKKENCpysILEITSVEIGVVAVKAINSnyyLAMNKKGKLYGSKEFNNDCK
LKERIEENgYNTYASFNWQHNGRQMYVALNGKGAPRRGQKTRRKNTSAHFLPMVVH
S.

FIG.15

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ATGGAGAACTGCCCCGTACAGCATCCTGGAGATAACATCAGTAGAAATCGGAGTTGT
TGCCGTCAAAGCCATTAAACAGCAACTATTACTTAGCCATGAACAAGAAGGGGAAAC
TCTATGGCTCAAAGAATTTAACAATGACTGTAAGCTGAAGGAGAGGATAGAGGAA
AATGGATACAATACCTATGCATCATTTAACTGGCAGCATAATGGGAGGCAAATGTA
TGTGGCATTGAATGGAAAAGGAGCTCCAAGGAGAGGACAGAAAACACGAAGGAAAA
ACACCTCTGCTCACTTTCTTCCAATGGTGGTACACTCATAG

MENCPSYLEITSVEIGVVAVKAINSNYLAMNKKGKLYGSKEFNNDCKLKERIEENGY
NTYASFNWQHNGRQMYVALNGKGAPRRGQKTRRKNTSAHFLPMVVHS.

FIG.16

ATGGTCAAAGCCATTAAACAGCAACTATTACTTAGCCATGAACAAGAAGGGGAACT
CTATGGCTCAAAGAATTTAACAATGACTGTAAGCTGAAGGAGAGGATAGAGGAAA
ATGGATACAATACCTATGCATCATTTAACTGGCAGCATAATGGGAGGCAAATGTAT
GTGGCATTGAATGGAAAAGGAGCTCCAAGGAGAGGACAGAAAACACGAAGGAAAAA
CACCTCTGCTCACTTTCTTCCAATGGTGGTACACTCATAG

MVKAINSNYLAMNKKGKLYGSKEFNNDCKLKERIEENGYNTYASFNWQHNGRQMY
VALNGKGAPRRGQKTRRKNTSAHFLPMVVHS.

FIG.17

ATGGGGAACTCTATGGCTCAAAGAATTTAACAATGACTGTAAGCTGAAGGAGAG
GATAGAGGAAAATGGATACAATACCTATGCATCATTTAACTGGCAGCATAATGGGA
GGCAAATGTATGTGGCATTGAATGGAAAAGGAGCTCCAAGGAGAGGACAGAAAACA
CGAAGGAAAACACCTCTGCTCACTTTCTTCCAATGGTGGTACACTCATAG

MGKLYGSKEFNNDCKLKERIEENGYNTYASFNWQHNGRQMYVALNGKGAPRRGQK
RRKNTSAHFLPMVVHS.

FIG.18

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ATGACCTGCCAGGCTCTGGGTCAGGACATGGTTTCTCCGGAAGCTACCAACTCTTCC
TCTTCCTCTTTCTCTTCCCGTCTTCCGCTGGTCGTACGTTTCGTTCTTACAACCAC
CTGCAGGGTGACGTTTCGTTGGCGTAACTGTTCTCTTTCACCAAATACTTCTGAAA
ATCGAAAAAACGGTAAAGTTTCTGGGACCAAGAAGGAGAACTGCCCGTACAGCATC
CTGGAGATAACATCAGTAGAAATCGGAGTTGTTGCCGTCAAAGCCATTAACAGCAAC
TATTACTTAGCCATGAACAAGAAGGGGAACTCTATGGCTCAAAGAATTTAACAAT
GACTGTAAGCTGAAG

MTQALGQDMVSPEATNSSSSSFSSPSSAGRHVRSYNHLQGDVRWRKLSFTKYFLKIE
KNGKVS GTKKENC PYSILEITSVEIGVAVKAINS NYLAMNKKGLYGSKEFNNDCKL
K

FIG.19

ATGGCTGGTCGTACGTTTCGTTCTTACAACCACCTGCAGGGTGACGTTTCGTTGGCGT
AAACTGTTCTTTTCACCAAATACTTCTGAAAATCGAAAAAACGGTAAAGTTTCT
GGGACCAAGAAGGAGAACTGCCCGTACAGCATCCTGGAGATAACATCAGTAGAAATC
GGAGTTGTTGCCGTCAAAGCCATTAACAGCAACTATTACTTAGCCATGAACAAGAAG
GGGAACTCTATGGCTCAAAGAATTTAACAATGACTGTAAGCTGAAG

MAGRHVRSYNHLQGDVRWRKLSFTKYFLKIEKNGKVS GTKKENC PYSILEITSVEIGV
VAVKAINS NYLAMNKKGLYGSKEFNNDCKLK

FIG.20

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C-37 To Ser

ATGACCTCTCAGGCTCTGGGTCAGGACATGGTTTCTCCGGAAGCTACCAACTCTTCC
TCTTCCTCTTTCTTTCCCGTCTTCCGCTGGTCGTACGTTGTTCTTACAACCAC
CTGCAGGGTGACGTTGTTGGCGTAACTGTTCTTTTACCAAATACTTCCTGAAA
ATCGAAAAAACGGTAAAGTTTCTGGGACCAAGAAGGAGAACTGCCCGTACAGCATC
CTGGAGATAACATCAGTAGAAATCGGAGTTGTTGCCGTCAAAGCCATTAAACAGCAAC
TATTACTTAGCCATGAACAAGAAGGGGAACTCTATGGCTCAAAAGAATTTAACAAT
GACTGTAAGCTGAAGGAGAGGATAGAGGAAAATGGATAACAATACCTATGCATCATTT
AACTGGCAGCATAATGGGAGGCAAATGTATGTGGCATTGAATGAAAAGGAGCTCCA
AGGAGAGGACAGAAAACACGAAGGAAAAACACCTCTGCTCACTTTCTTCCAATGGTG
GTACACTCATAG

FIG.21

C-106 To Ser

ATGACCTGCCAGGCTCTGGGTCAGGACATGGTTTCTCCGGAAGCTACCAACTCTTCC
TCTTCCTCTTTCTTTCCCGTCTTCCGCTGGTCGTACGTTGTTCTTACAACCAC
CTGCAGGGTGACGTTGTTGGCGTAACTGTTCTTTTACCAAATACTTCCTGAAA
ATCGAAAAAACGGTAAAGTTTCTGGGACCAAGAAGGAGAACTCTCCGTACAGCATC
CTGGAGATAACATCAGTAGAAATCGGAGTTGTTGCCGTCAAAGCCATTAAACAGCAAC
TATTACTTAGCCATGAACAAGAAGGGGAACTCTATGGCTCAAAAGAATTTAACAAT
GACTGTAAGCTGAAGGAGAGGATAGAGGAAAATGGATAACAATACCTATGCATCATTT
AACTGGCAGCATAATGGGAGGCAAATGTATGTGGCATTGAATGAAAAGGAGCTCCA
AGGAGAGGACAGAAAACACGAAGGAAAAACACCTCTGCTCACTTTCTTCCAATGGTG
GTACACTCATAG

FIG.22

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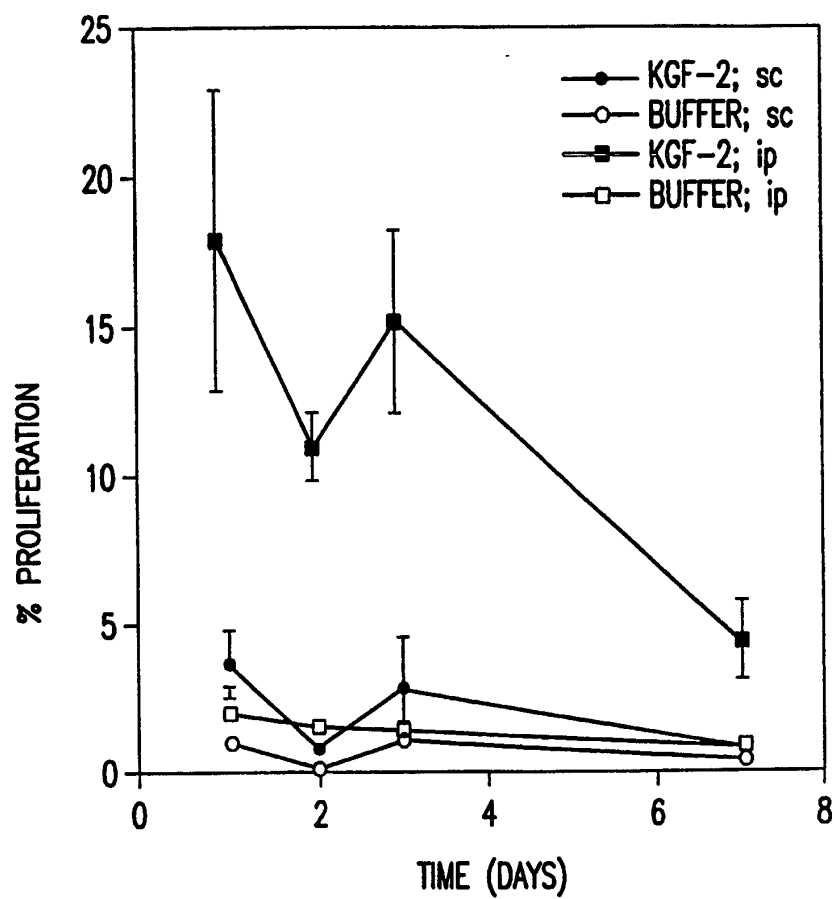


FIG.23

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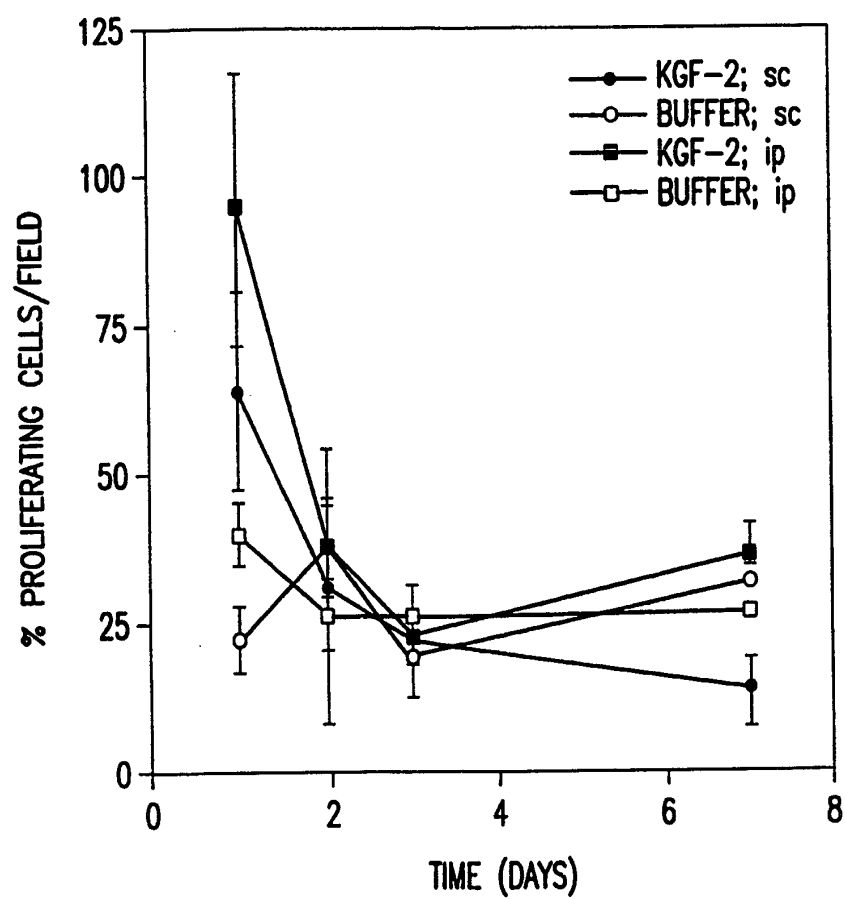
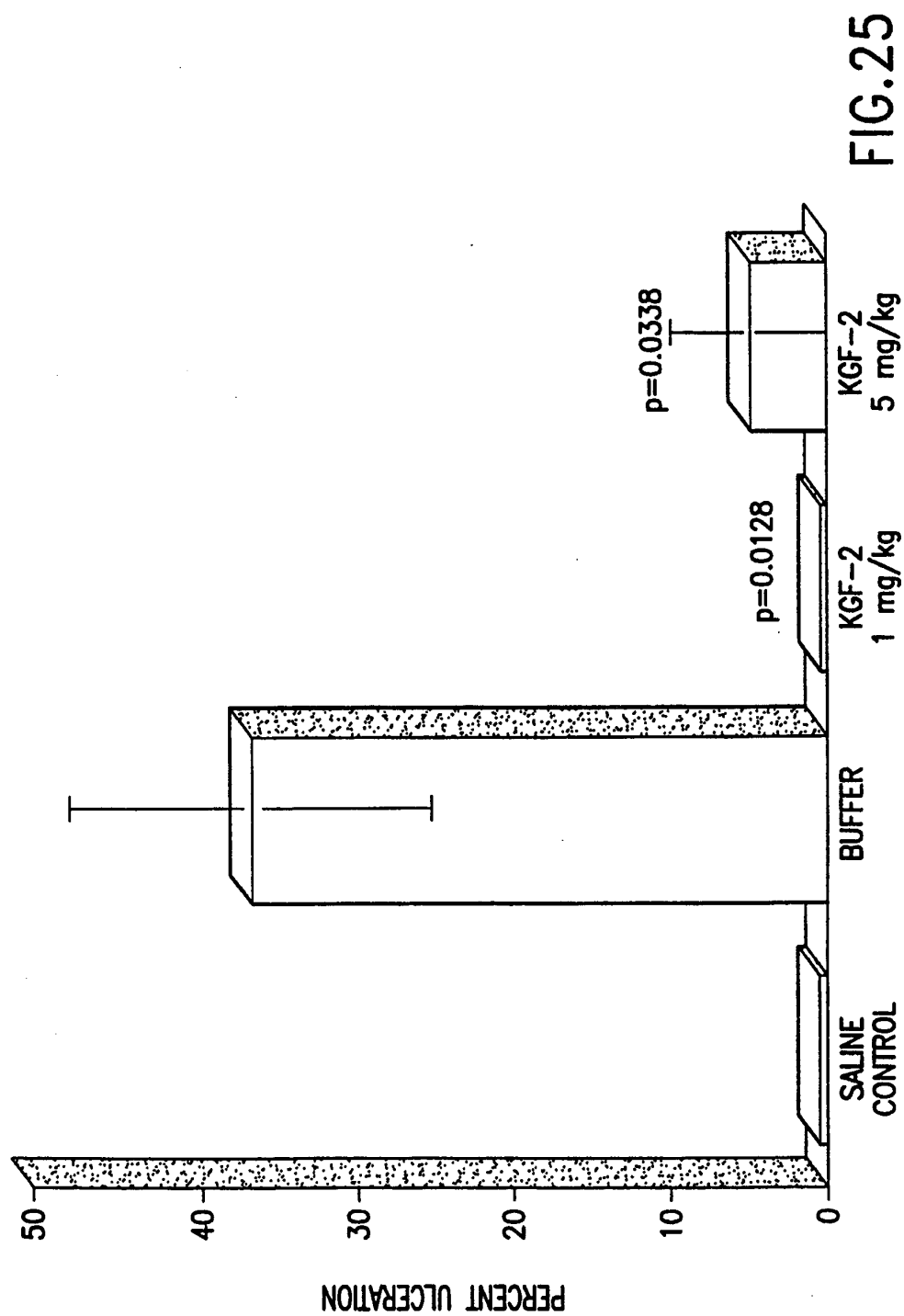
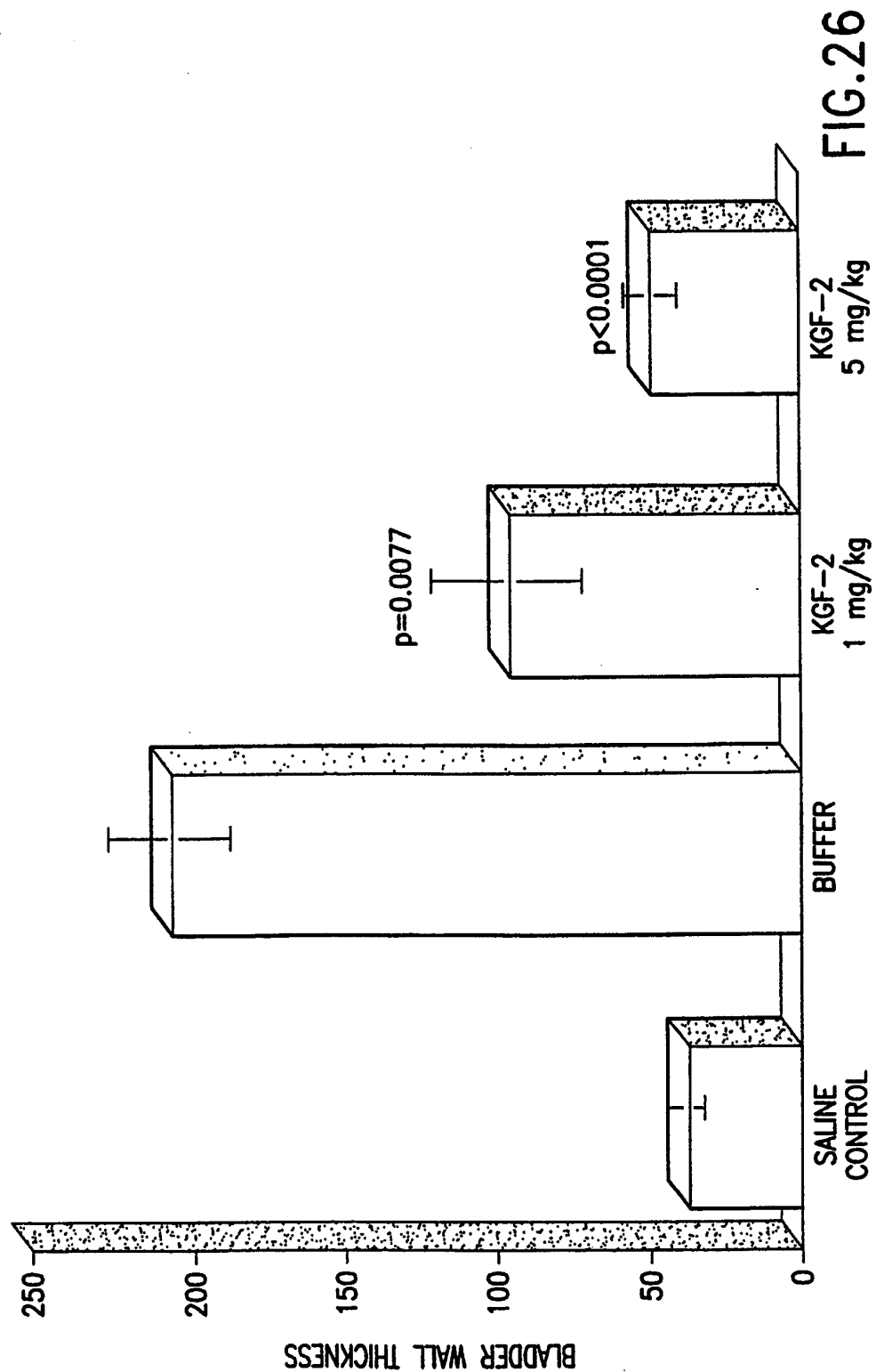


FIG.24

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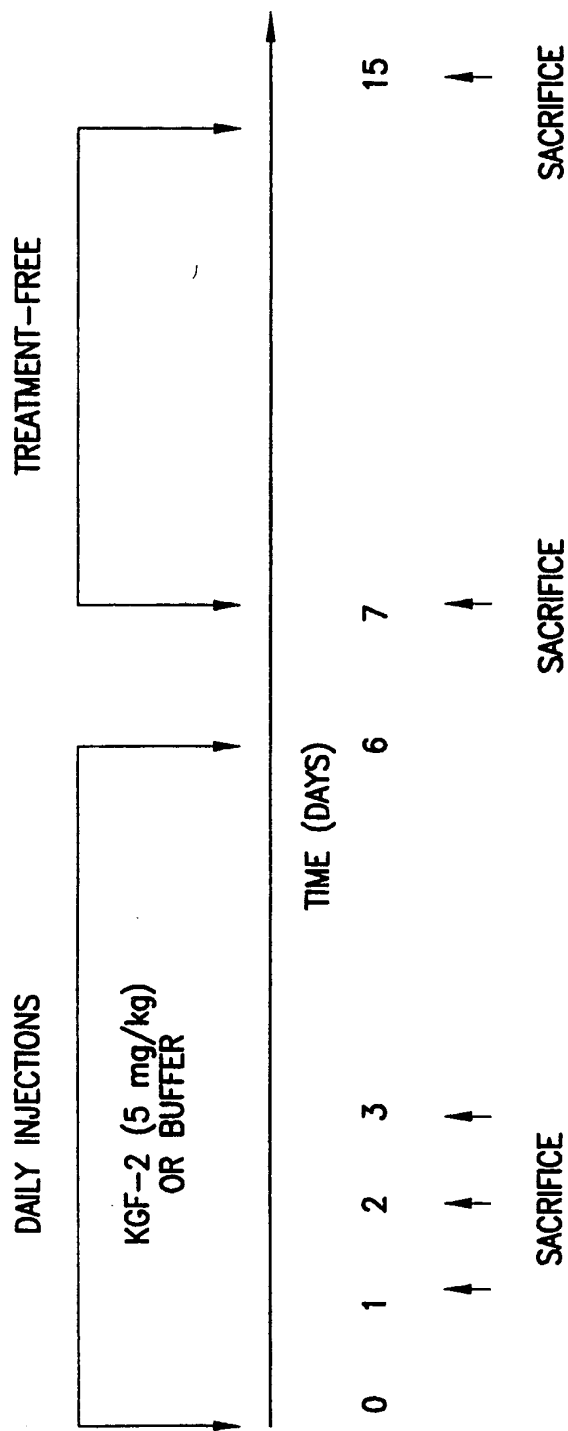


FIG.27

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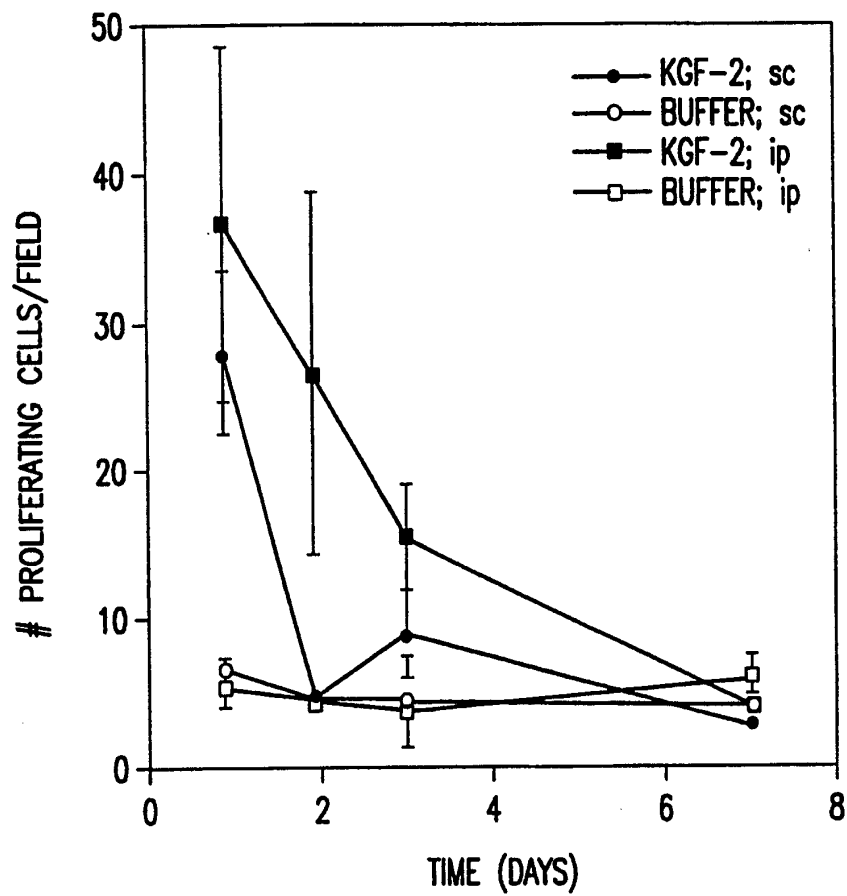


FIG.28

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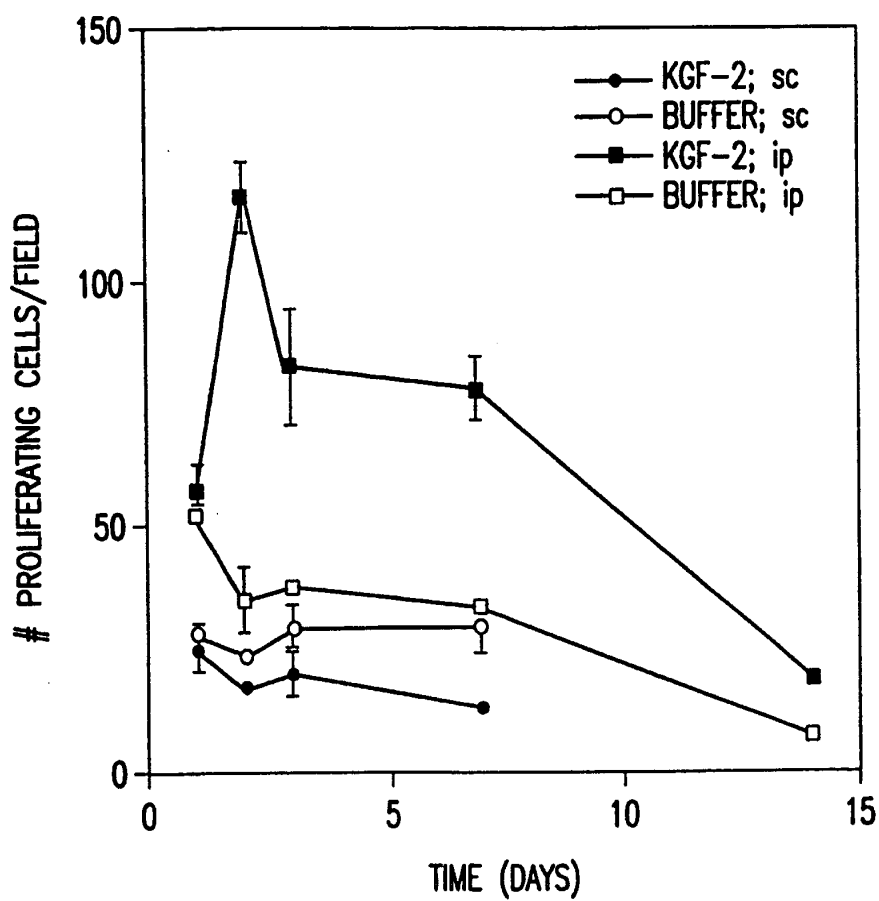


FIG.29

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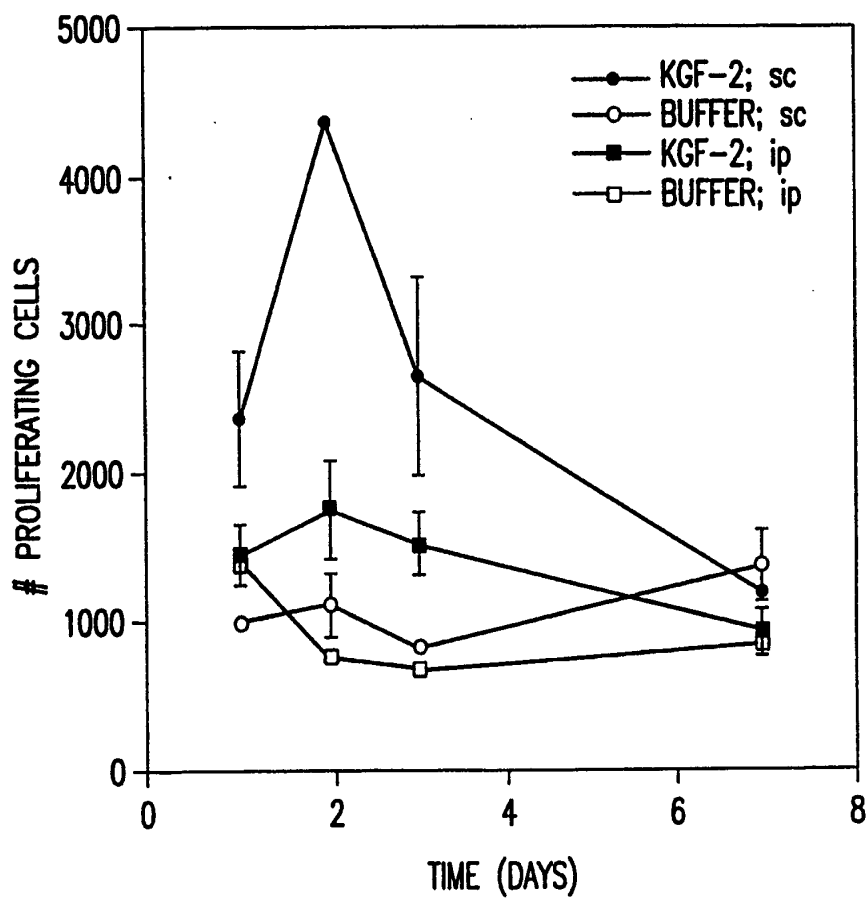
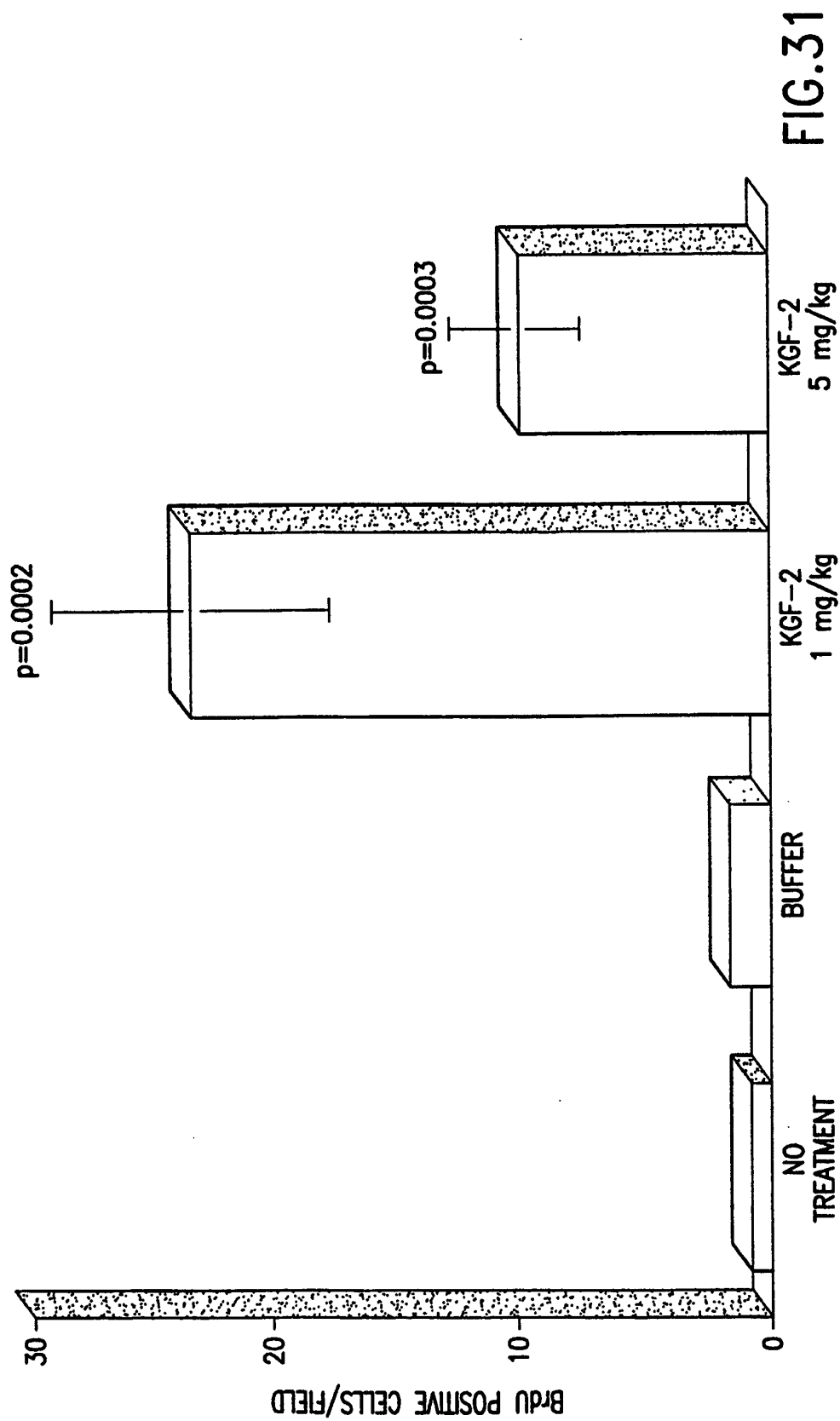
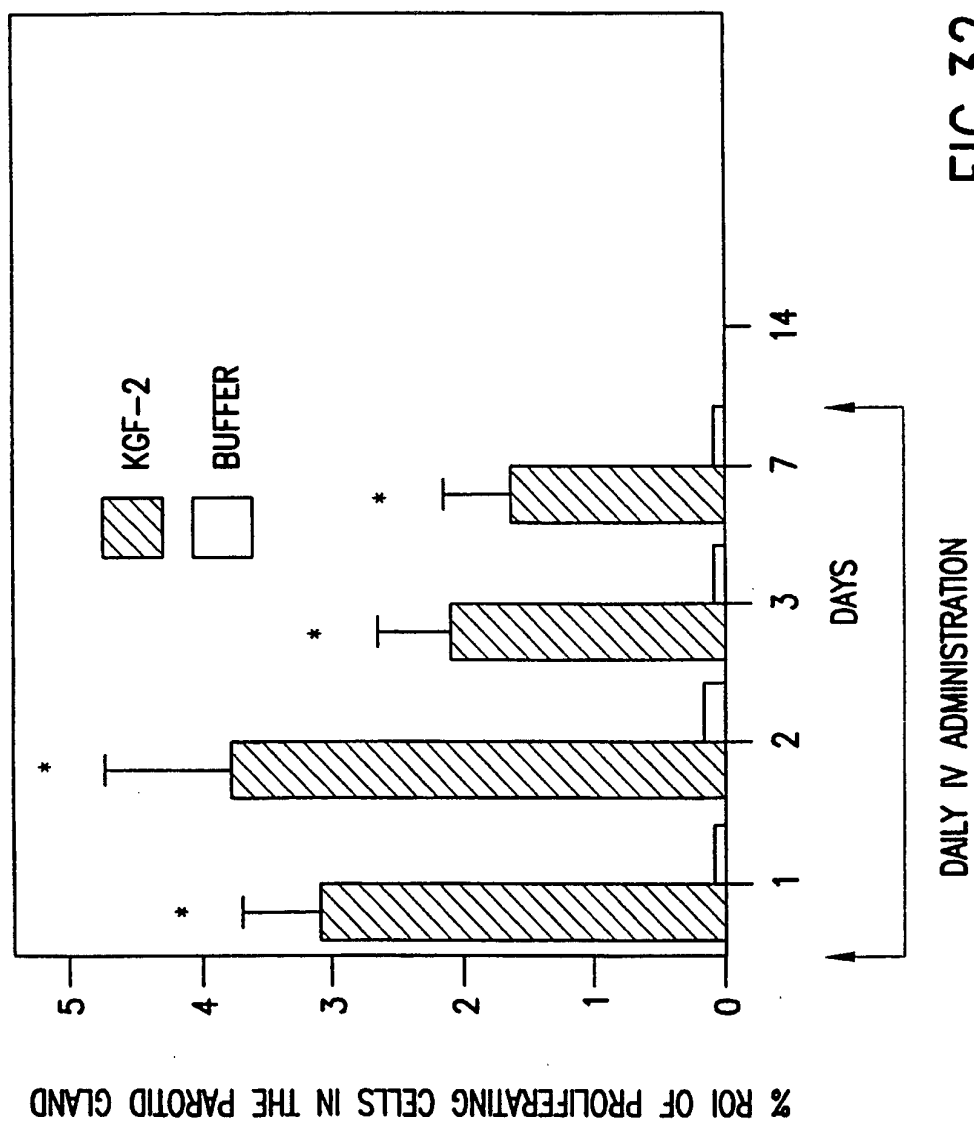


FIG.30

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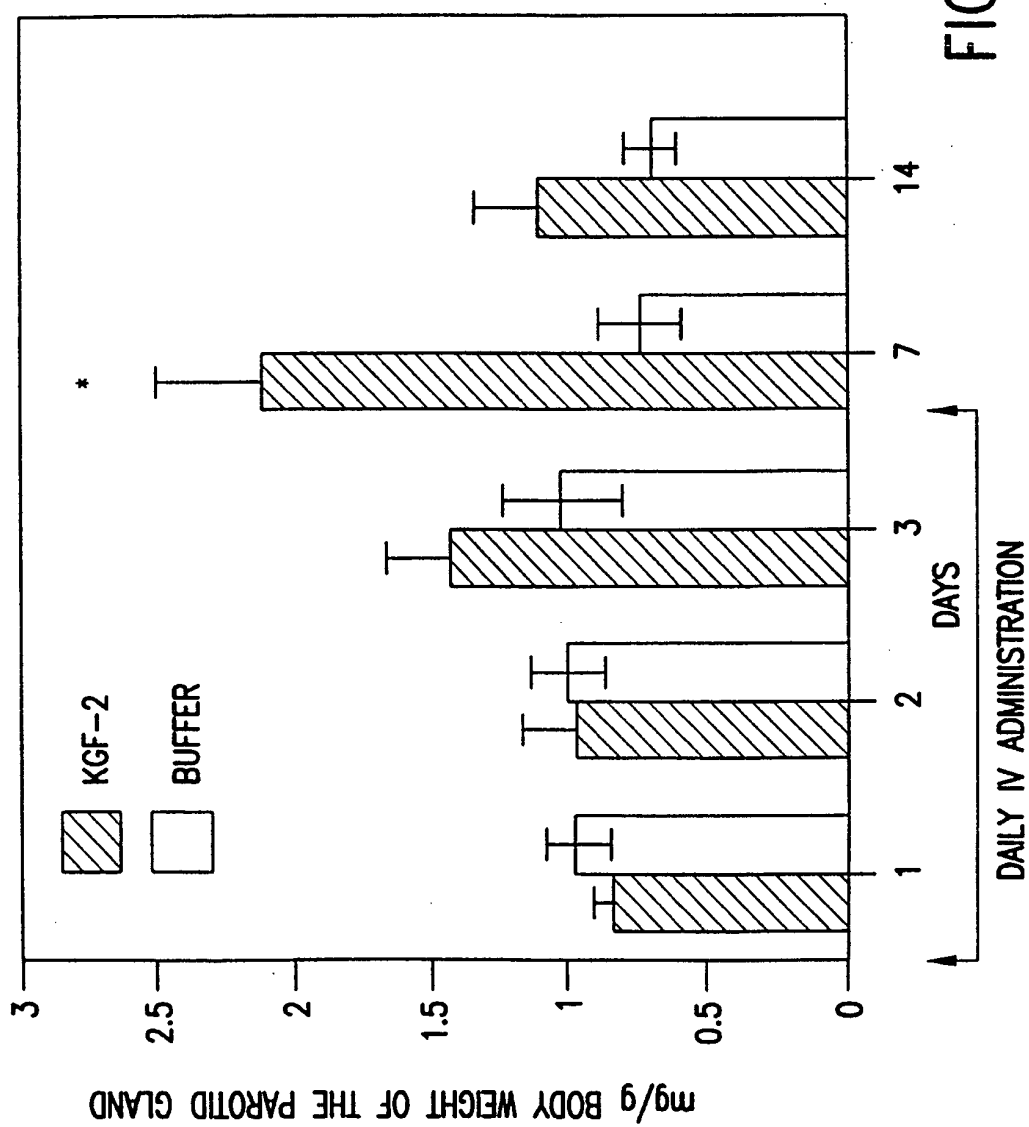


FIG. 33

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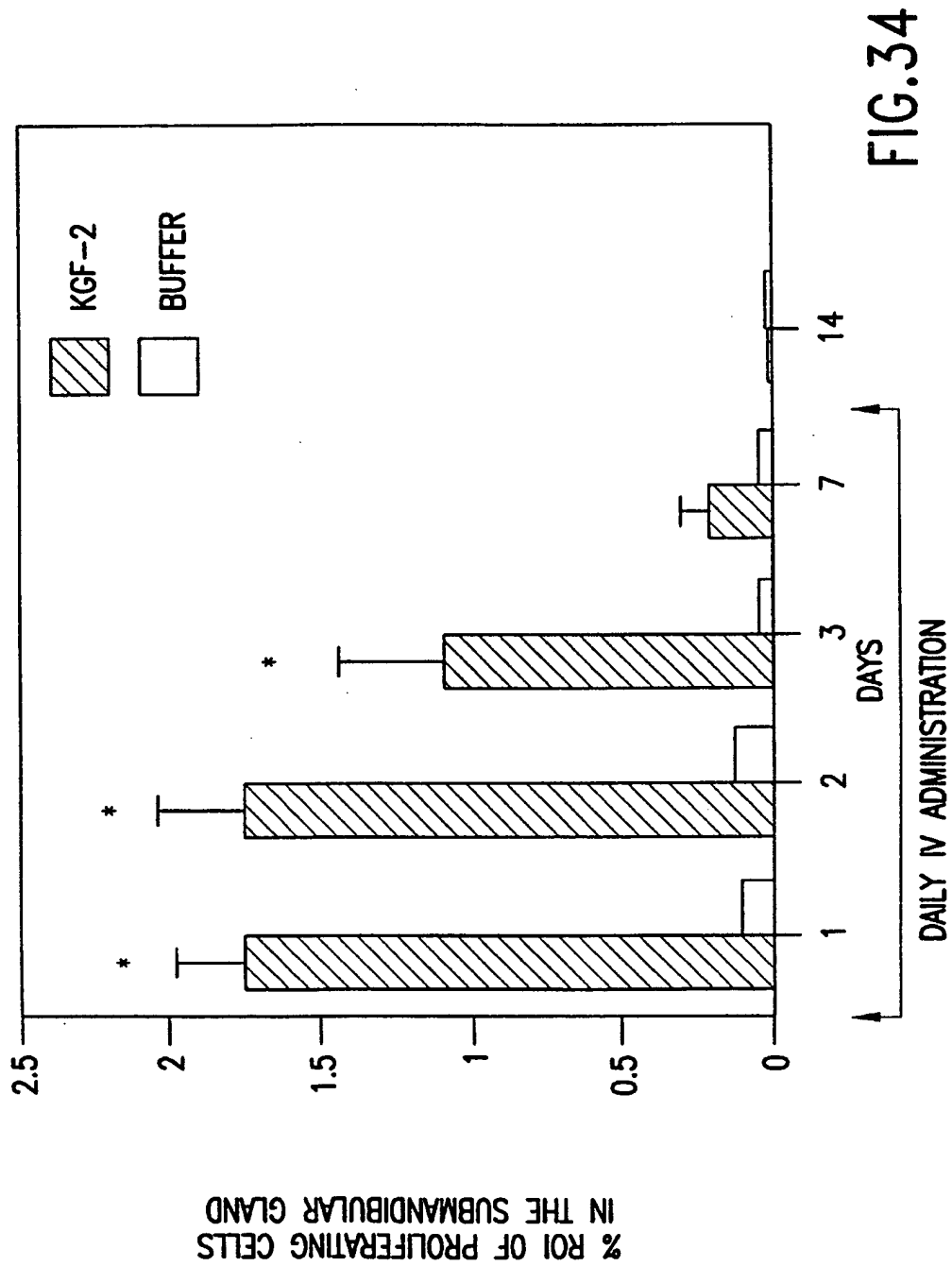


FIG.34

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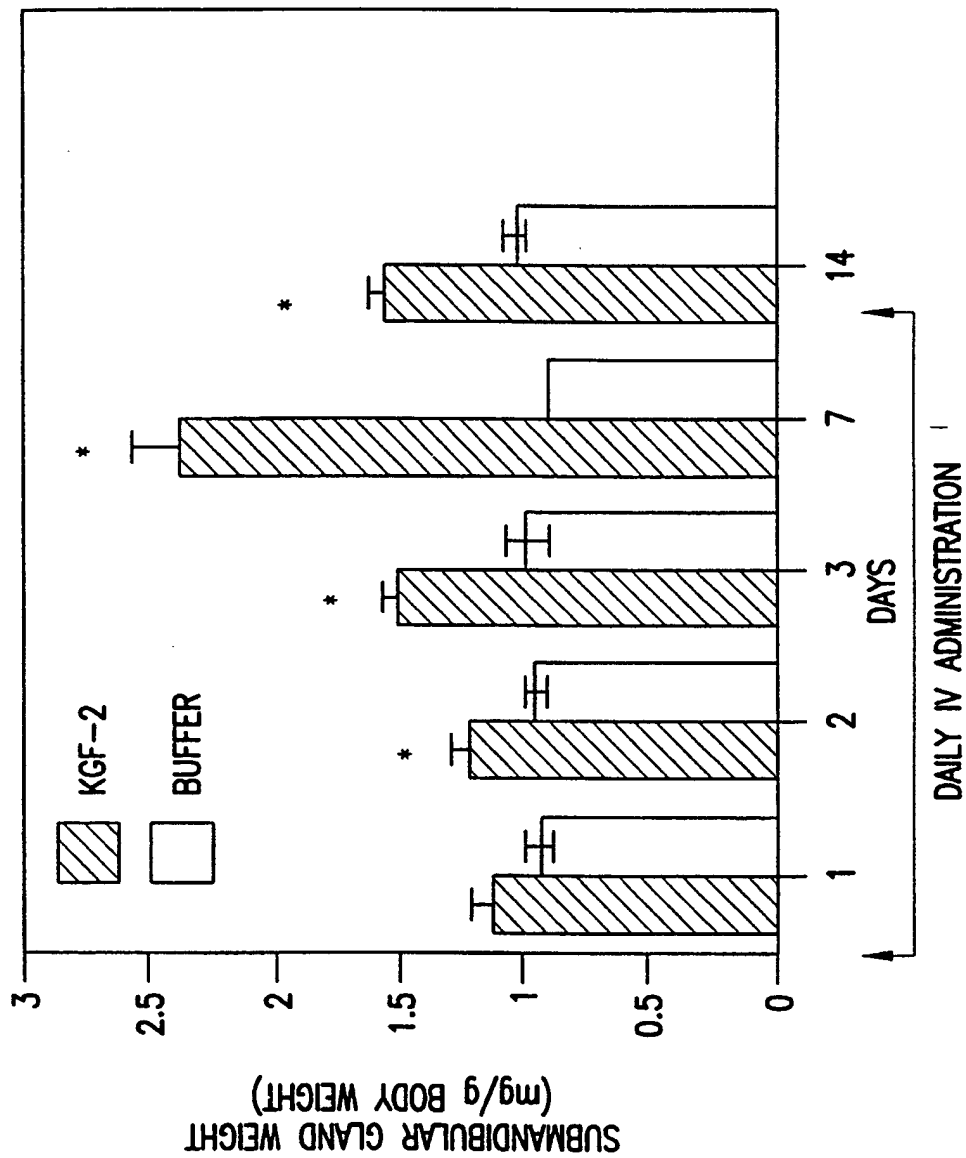


FIG.35

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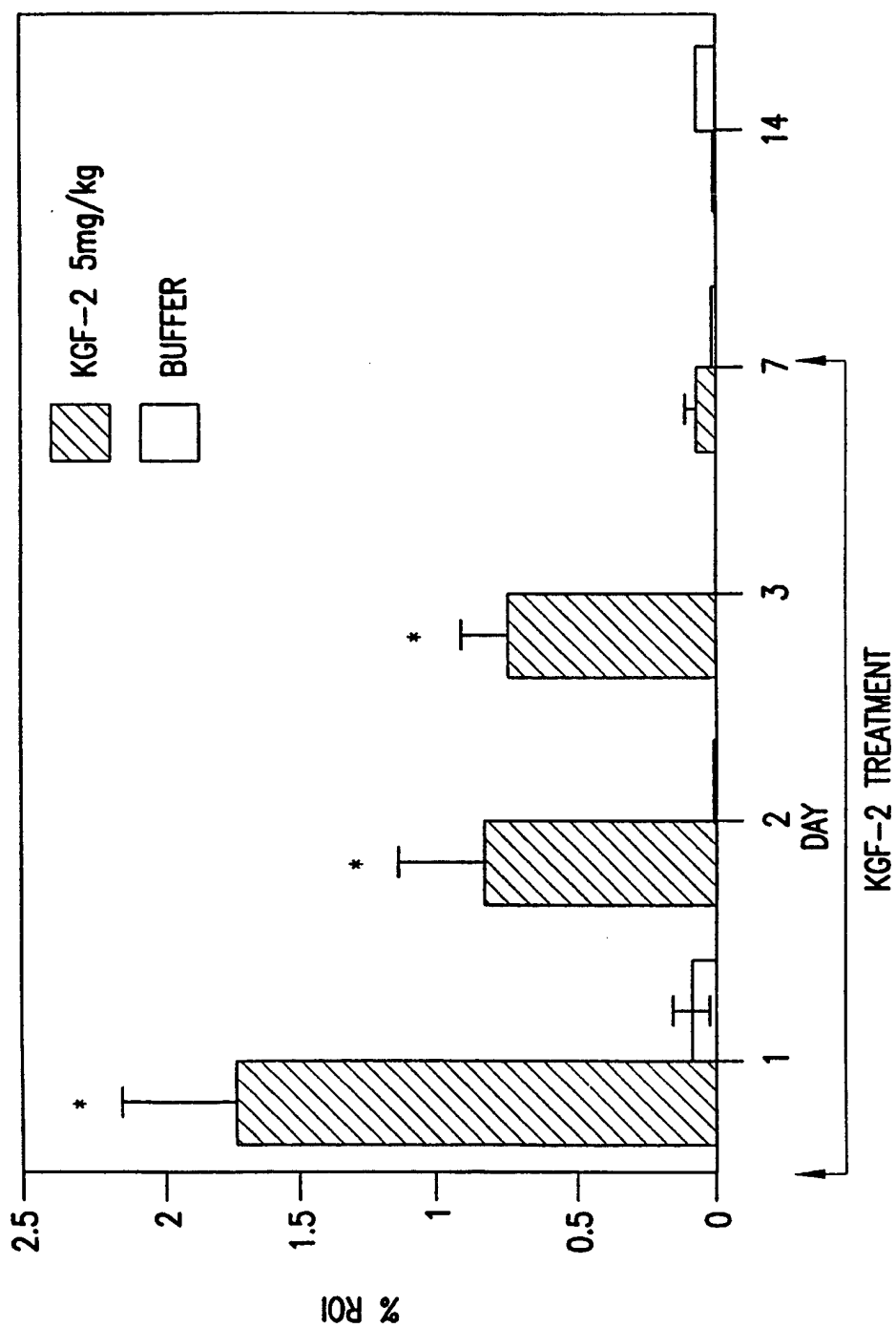
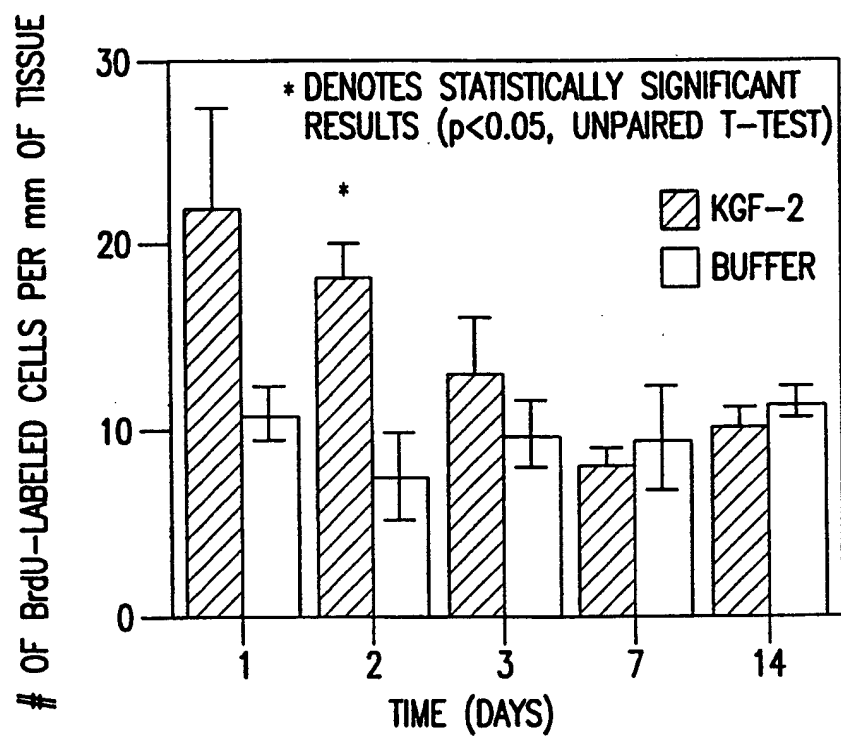


FIG.36

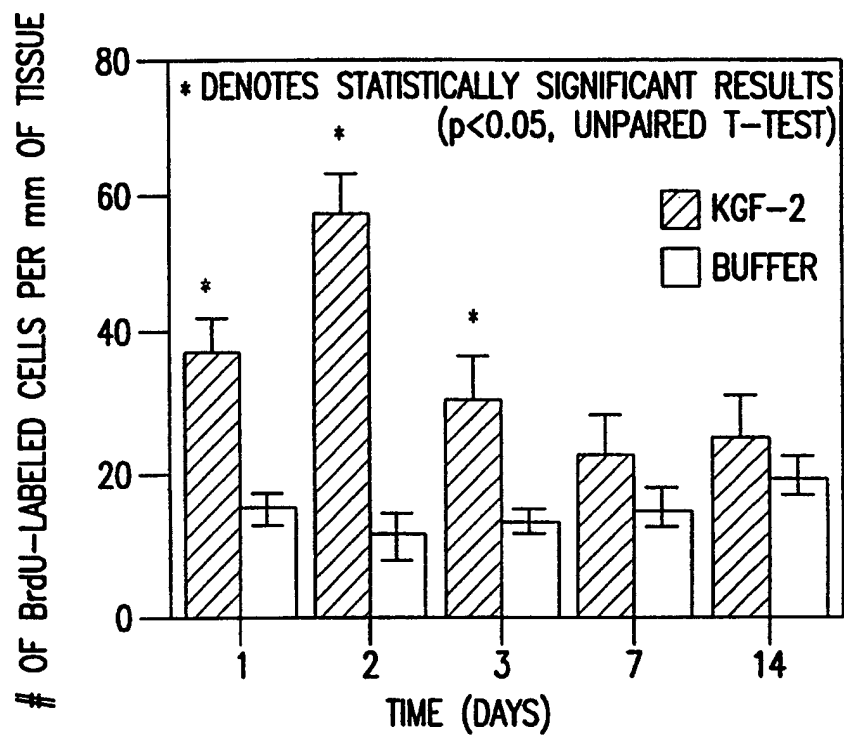
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DAYS	KGF-2		BUFFER	
	MEAN	SEM	MEAN	SEM
1	21.95	5.55	10.99	1.45
2	18.25	1.86	7.49	2.31
3	13.33	2.59	9.8	1.8
7	8.05	1.11	9.56	2.85
14	10.27	0.93	11.51	0.78

FIG.37

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DAYS	KGF-2			BUFFER	
	MEAN	SEM		MEAN	SEM
1	37.42	4.55		15.03	2.15
2	57.59	5.39		11.19	3.21
3	31.25	6.05		13.52	1.57
7	23.64	5.77		15.56	2.95
14	26.35	6.02		20.56	2.95

FIG.38

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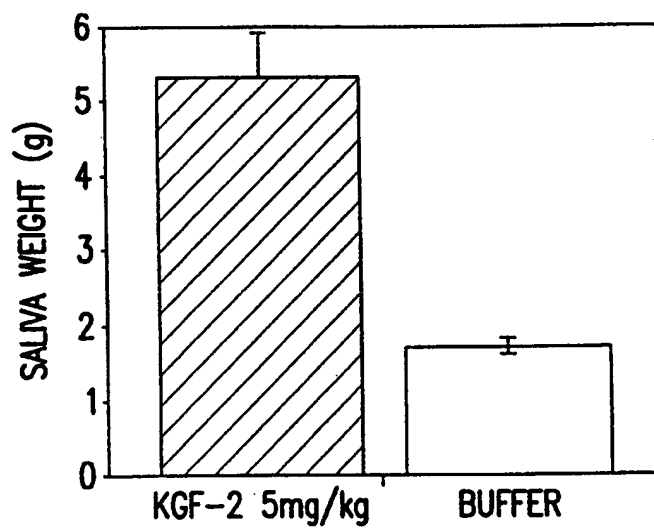


FIG.39A

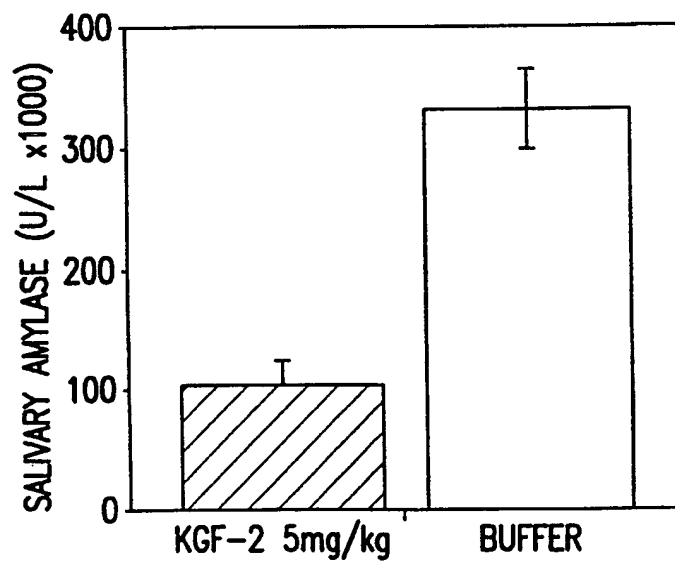


FIG.39B

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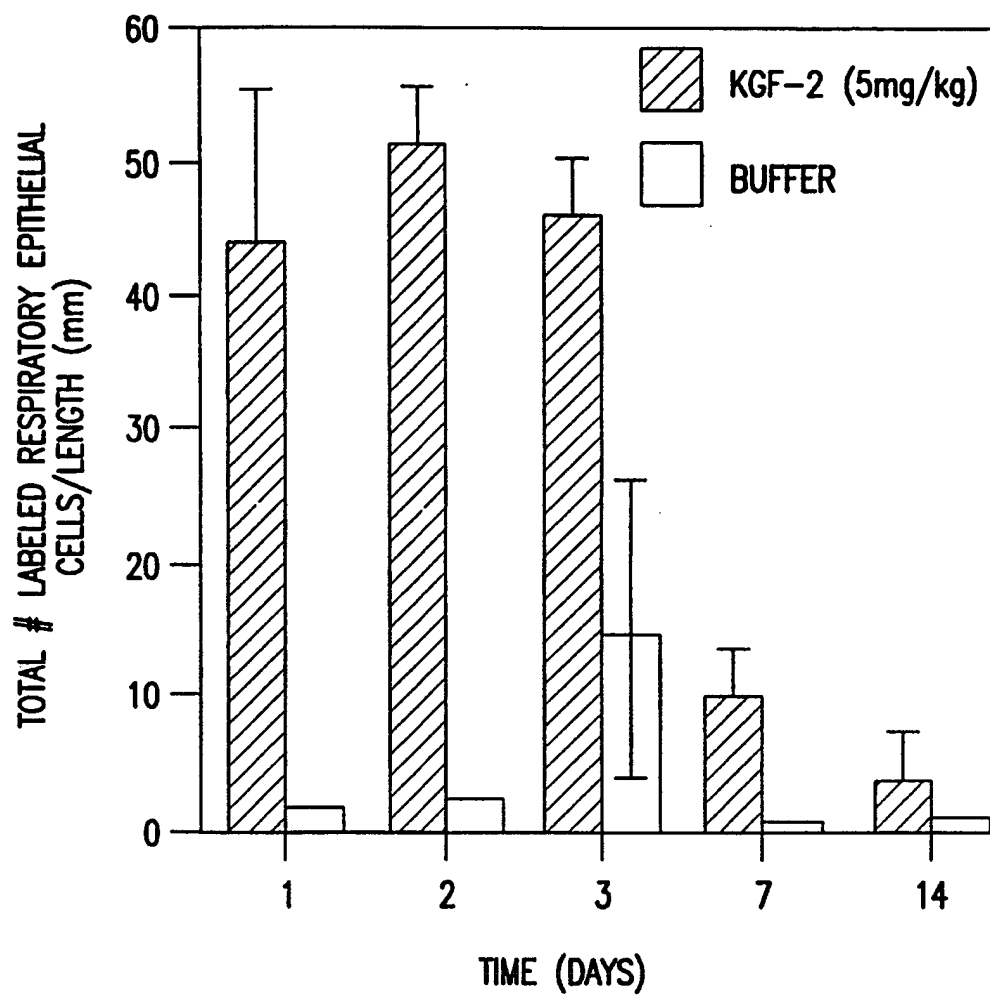


FIG.40

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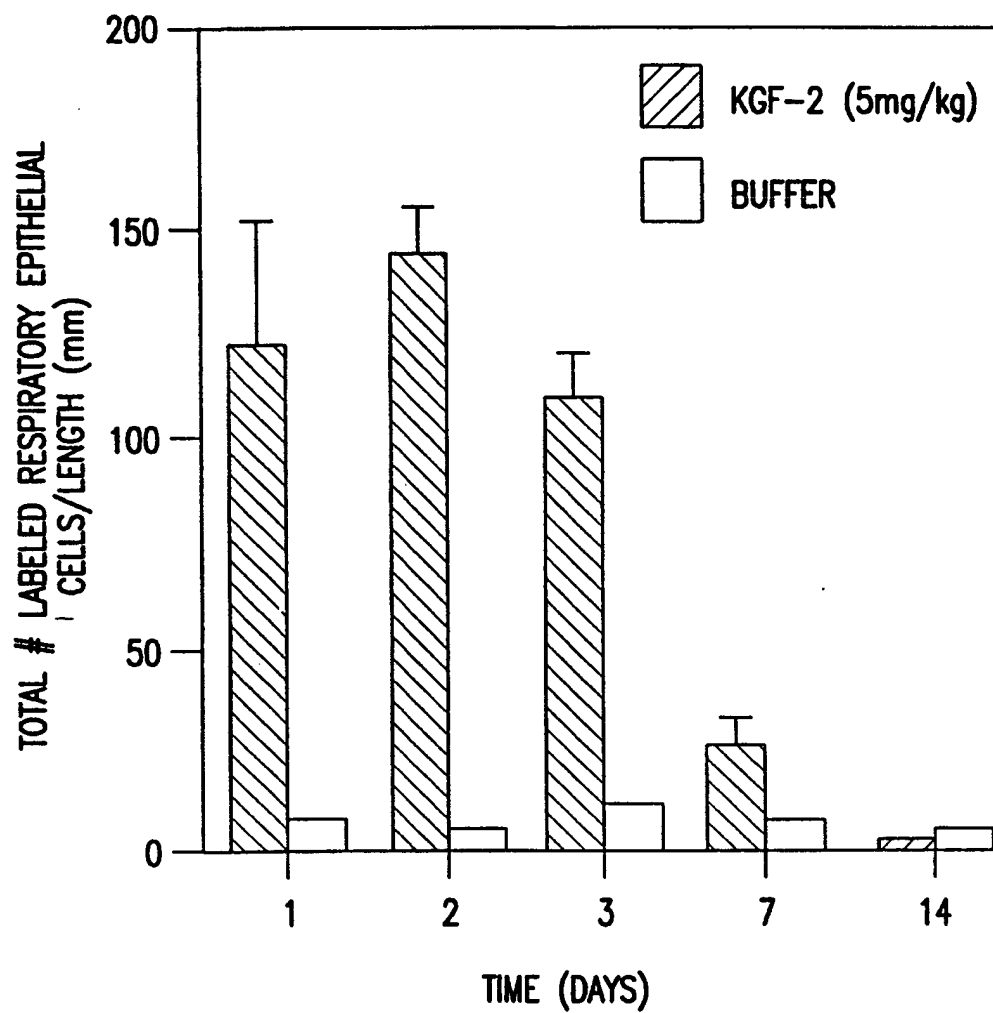


FIG.41

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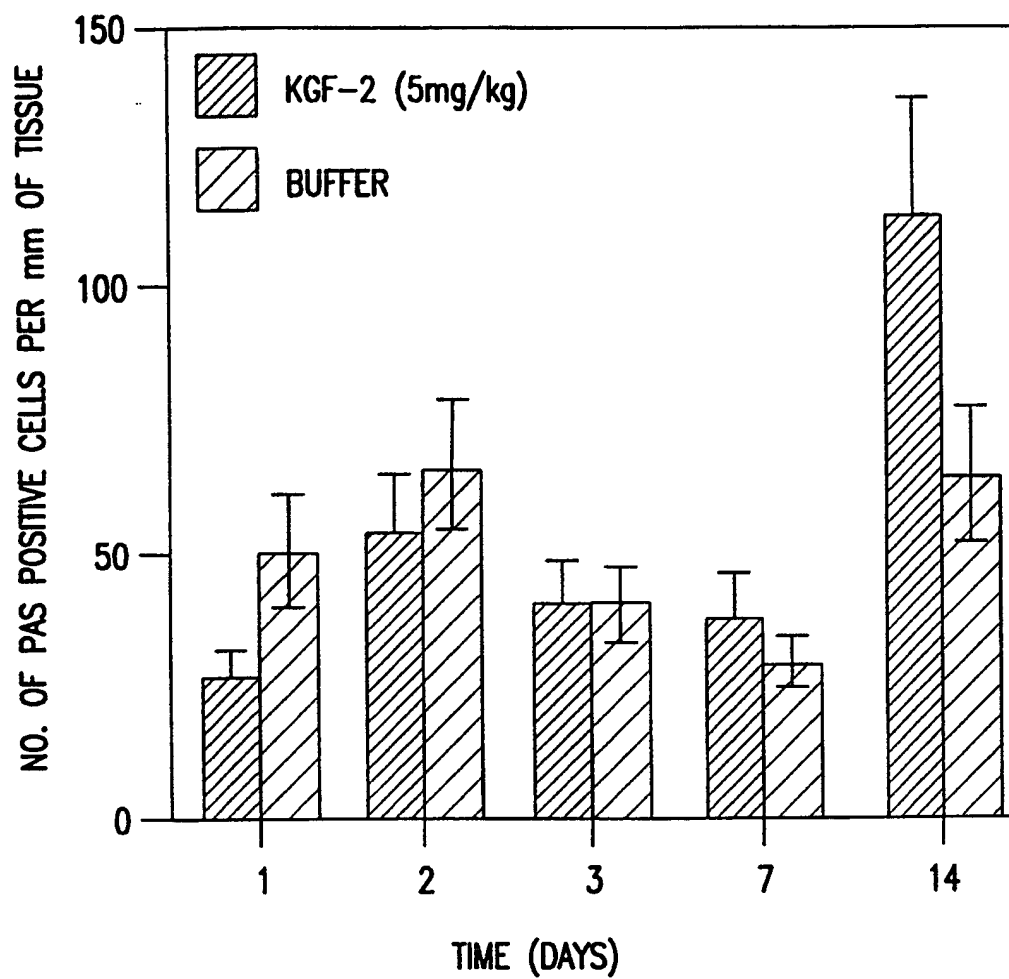


FIG.42

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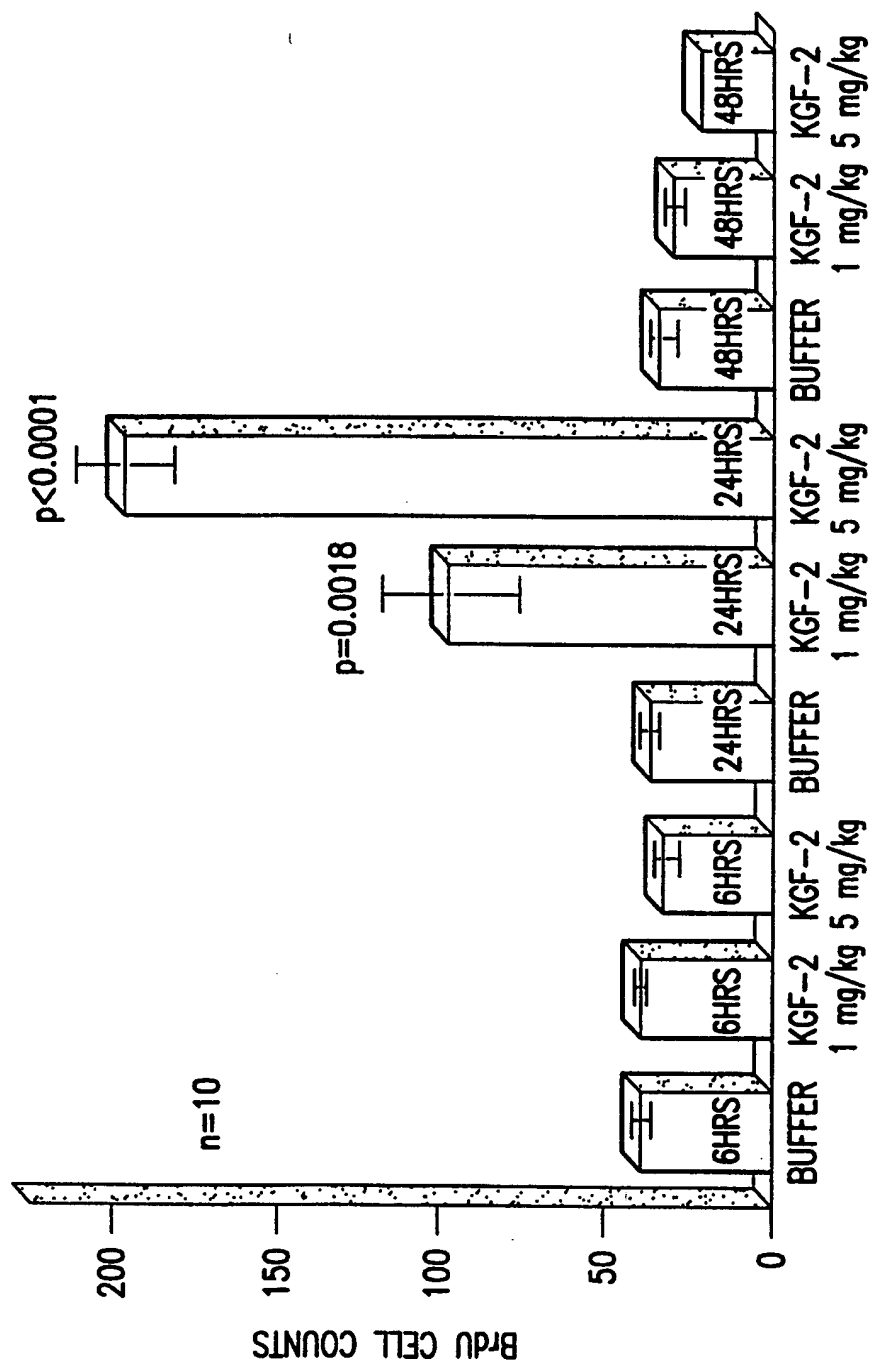


FIG. 43

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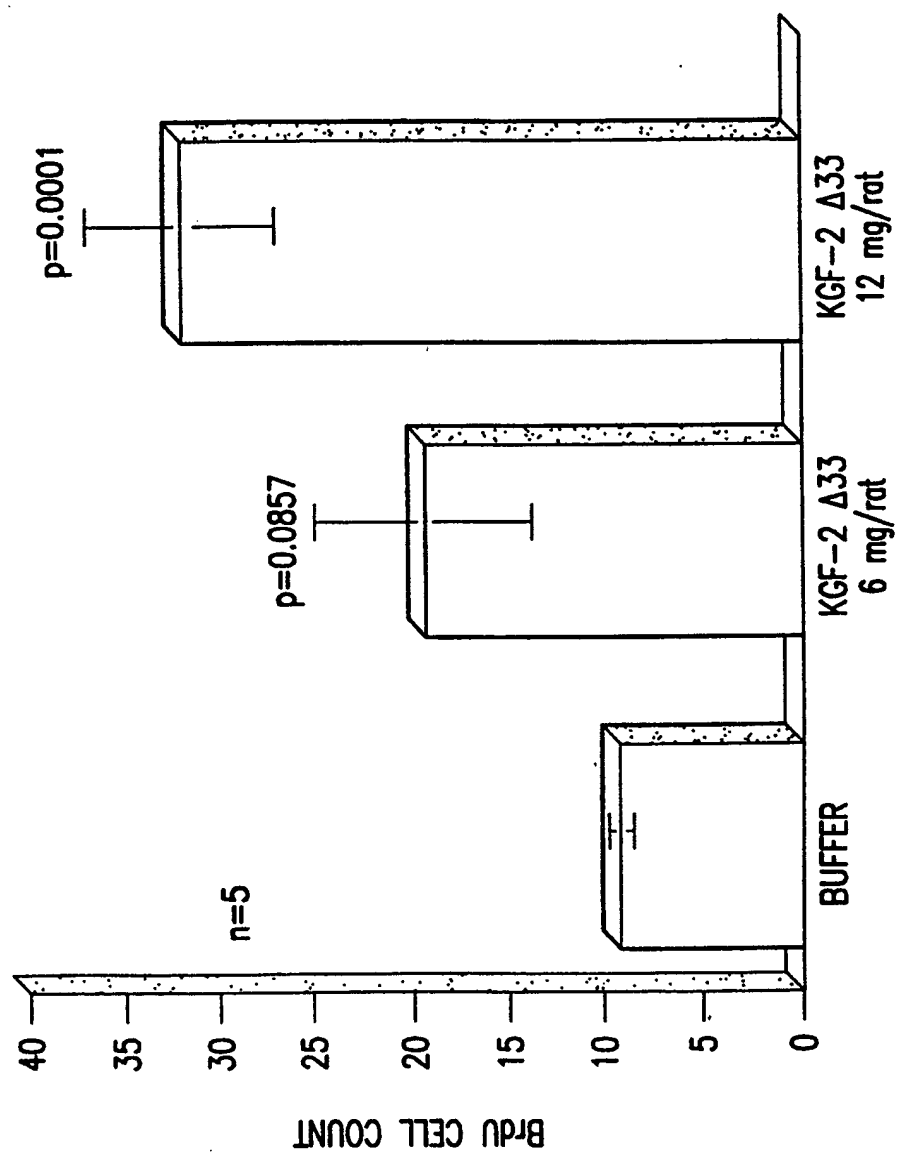


FIG.44

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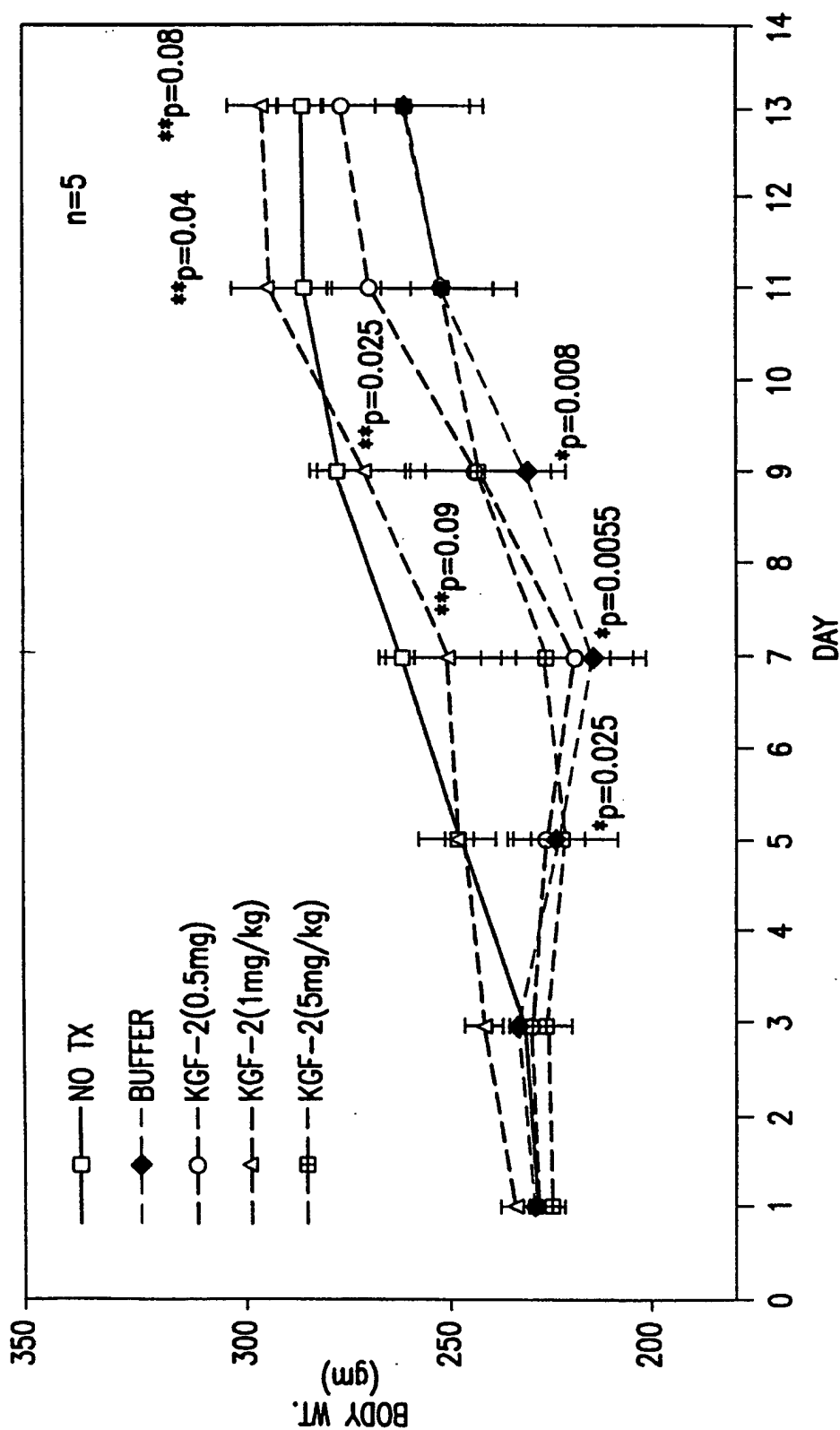


FIG. 45

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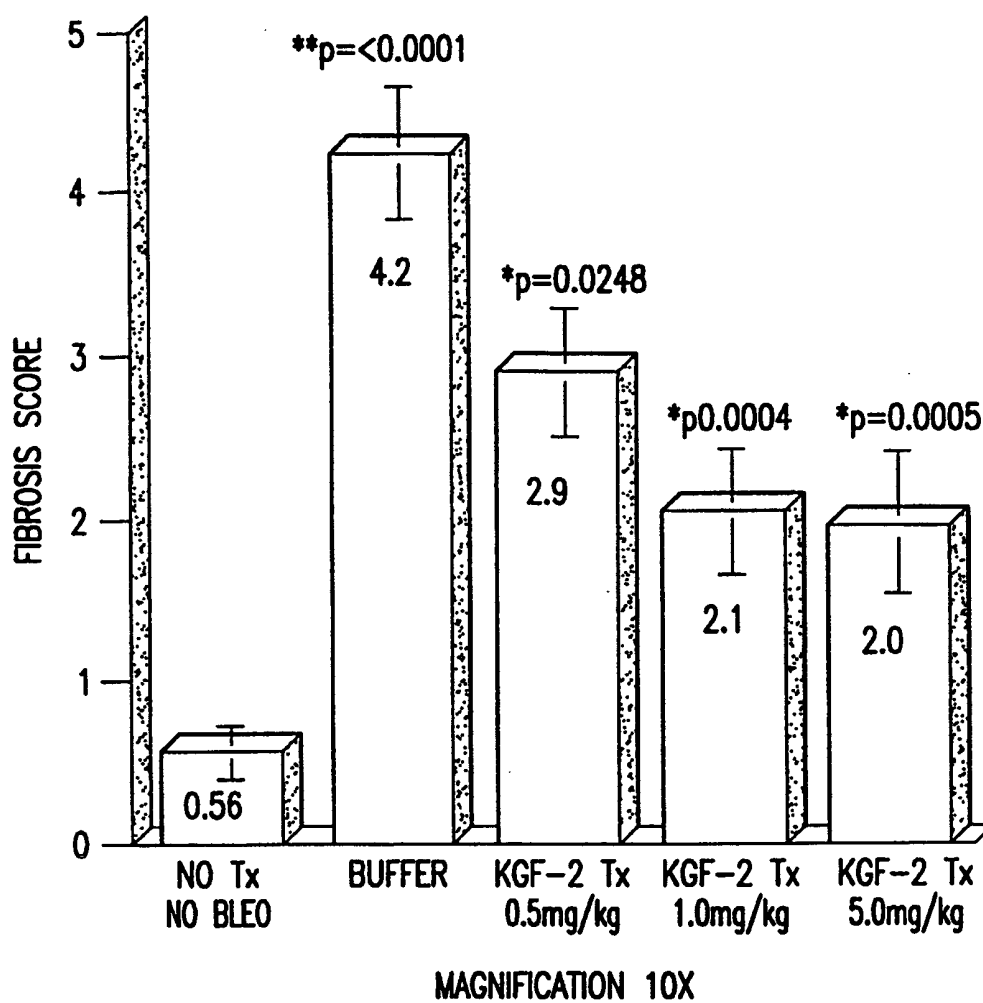


FIG.46

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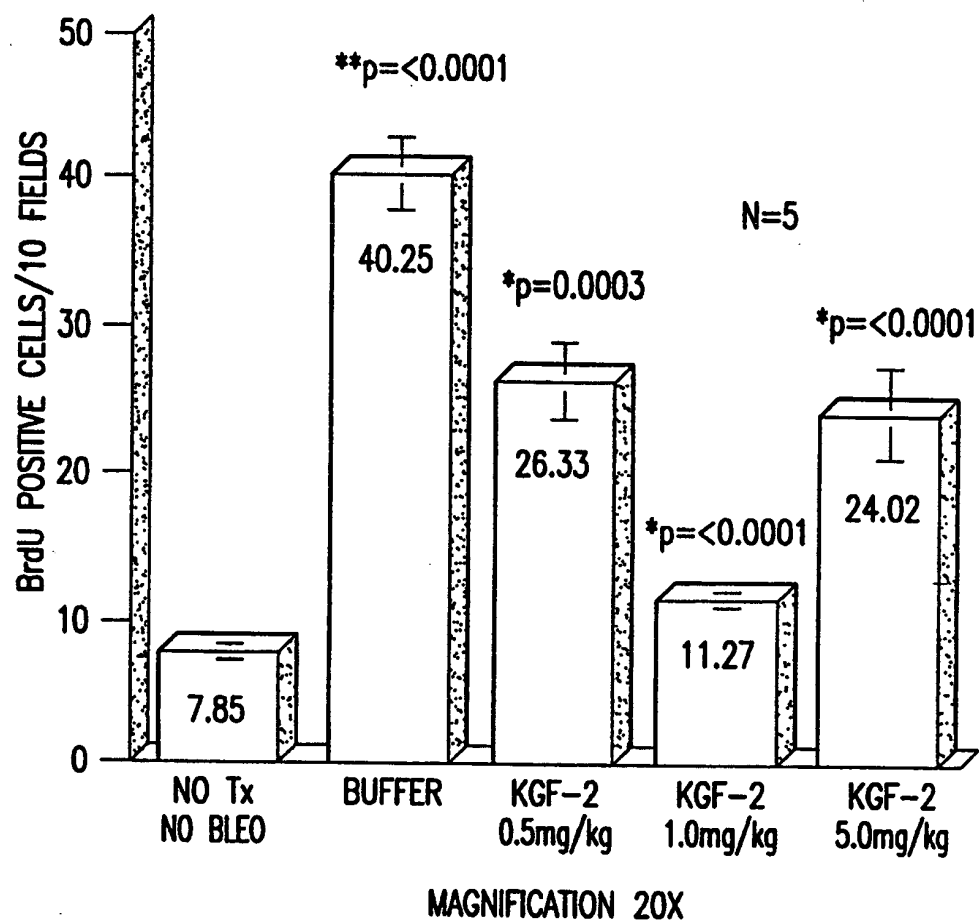


FIG.47

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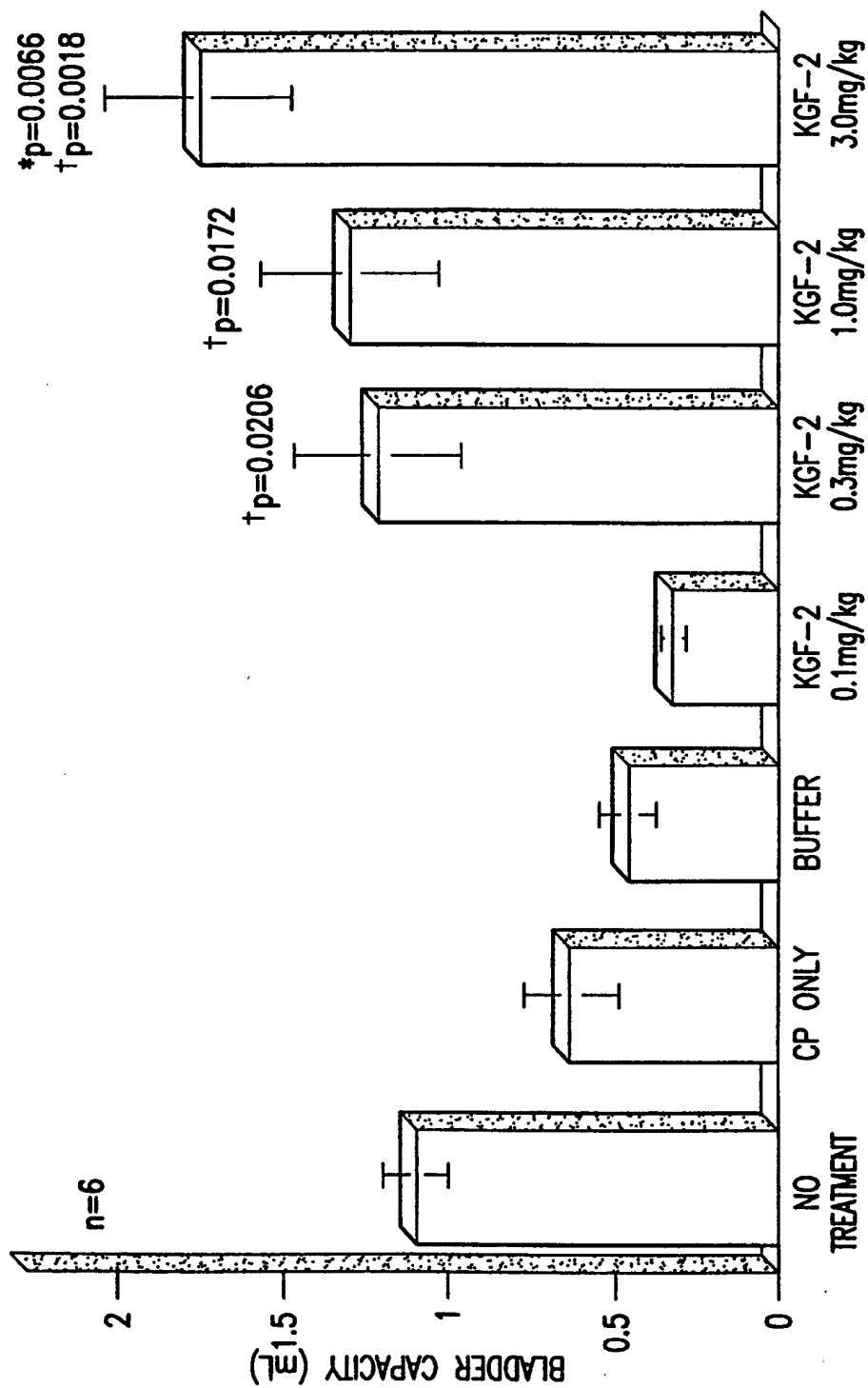


FIG. 48

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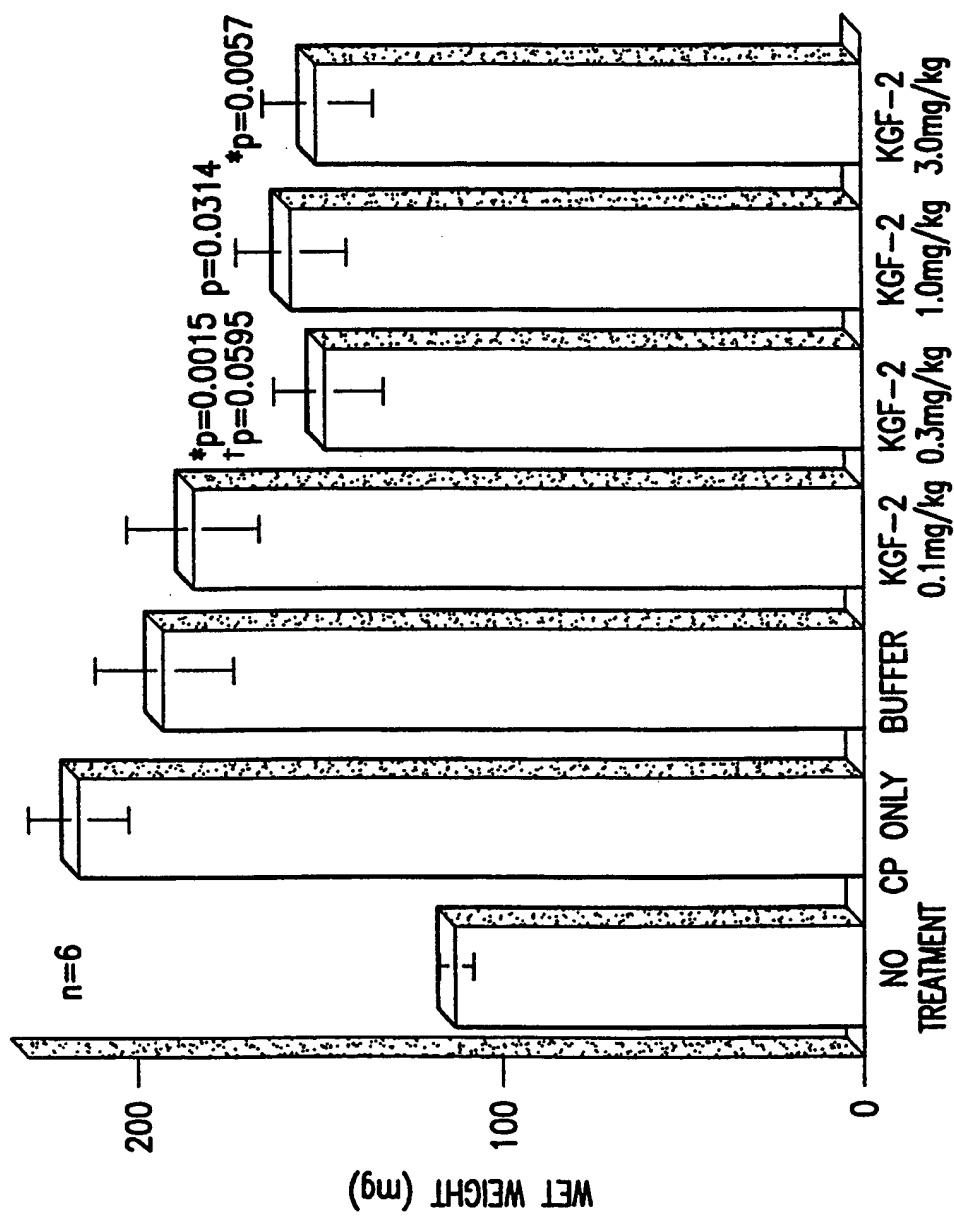


FIG.49

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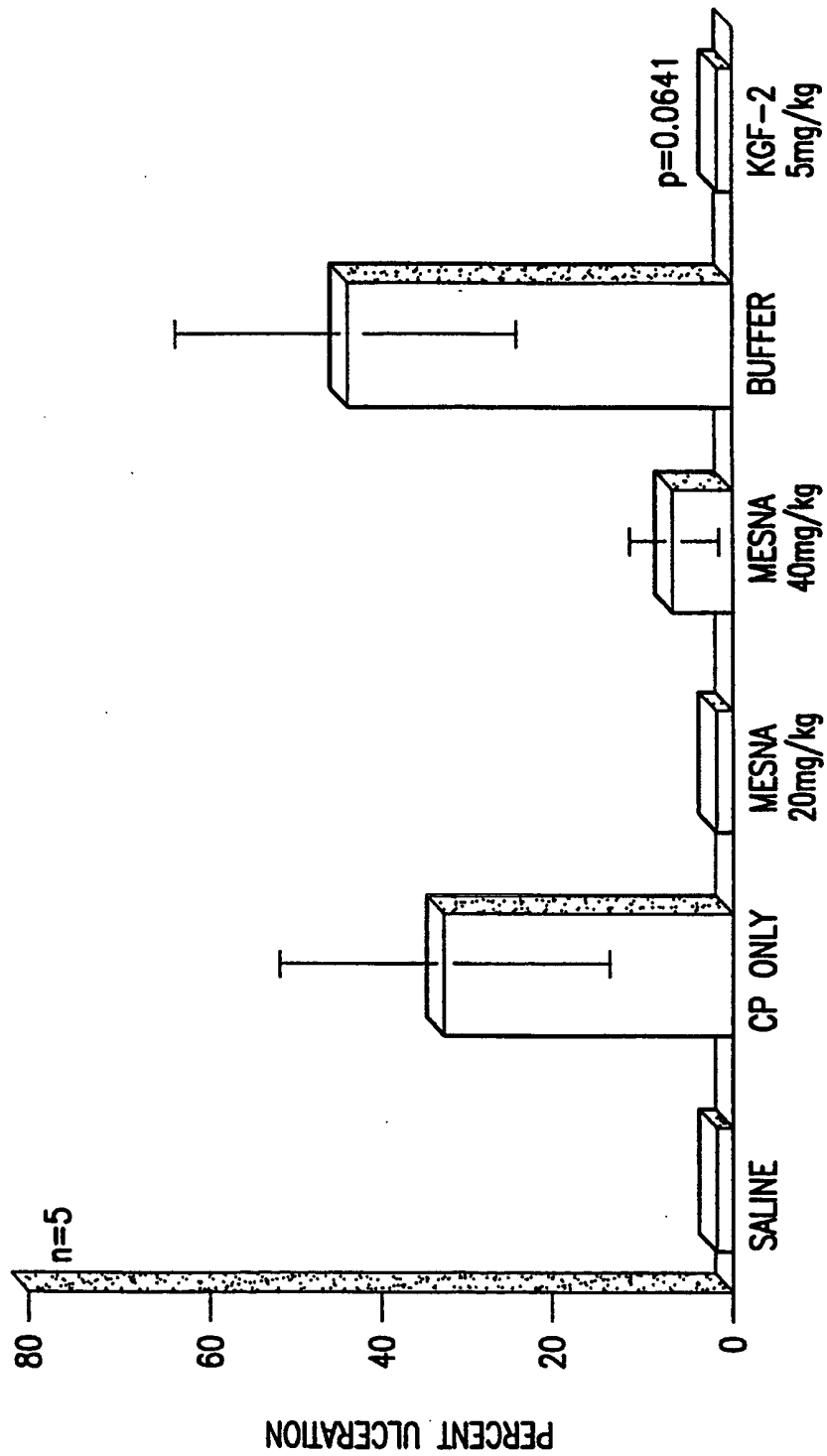


FIG.50

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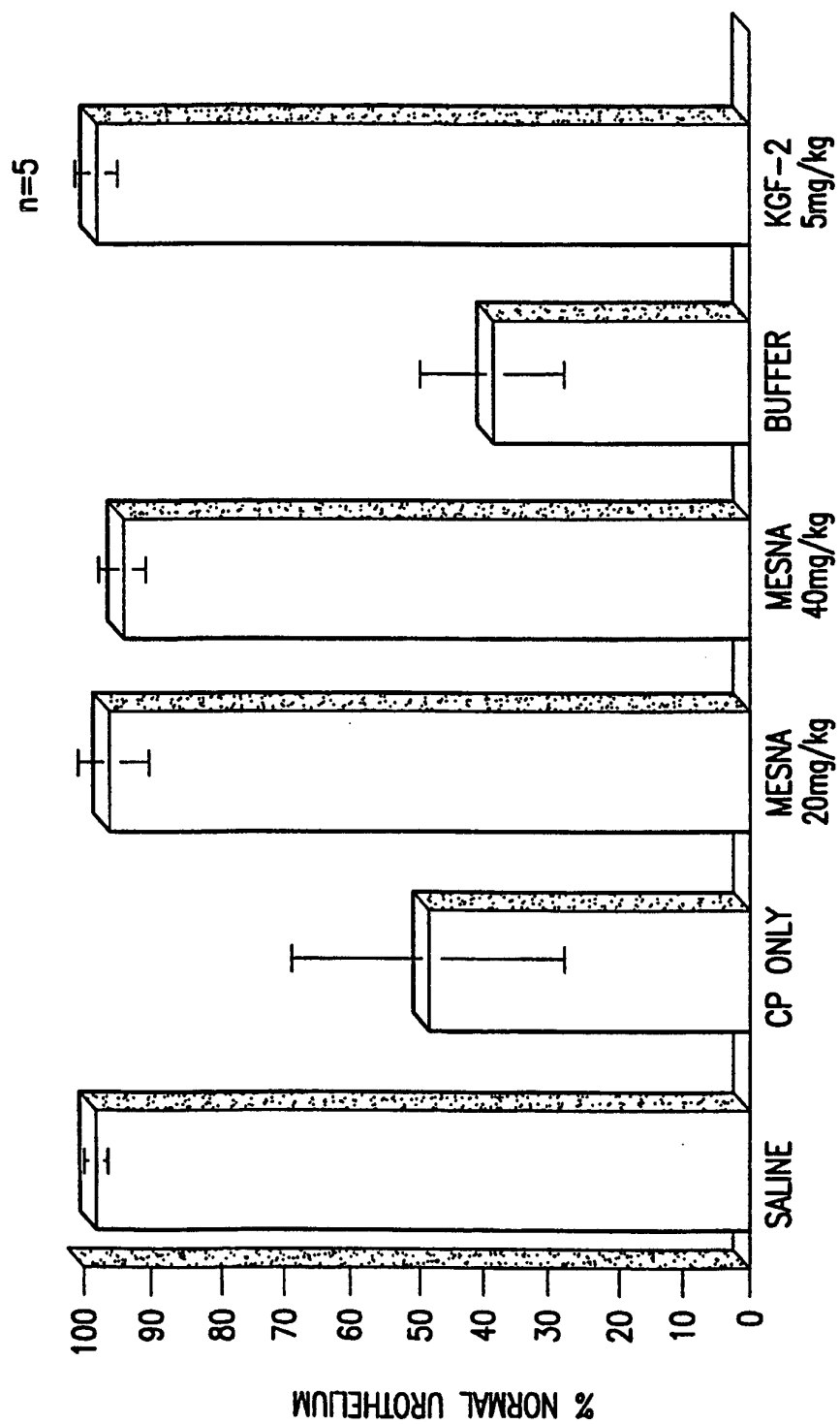


FIG.51

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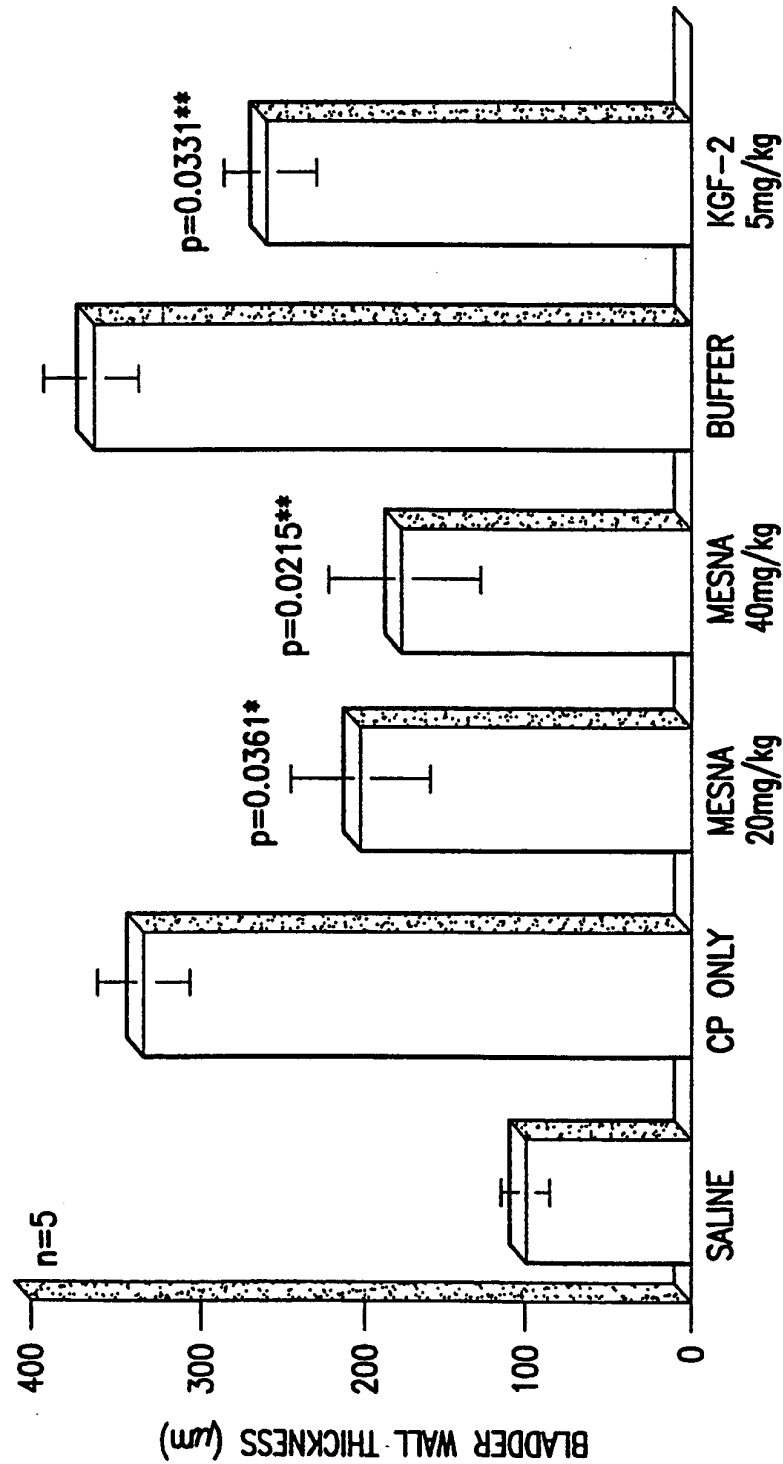


FIG. 52

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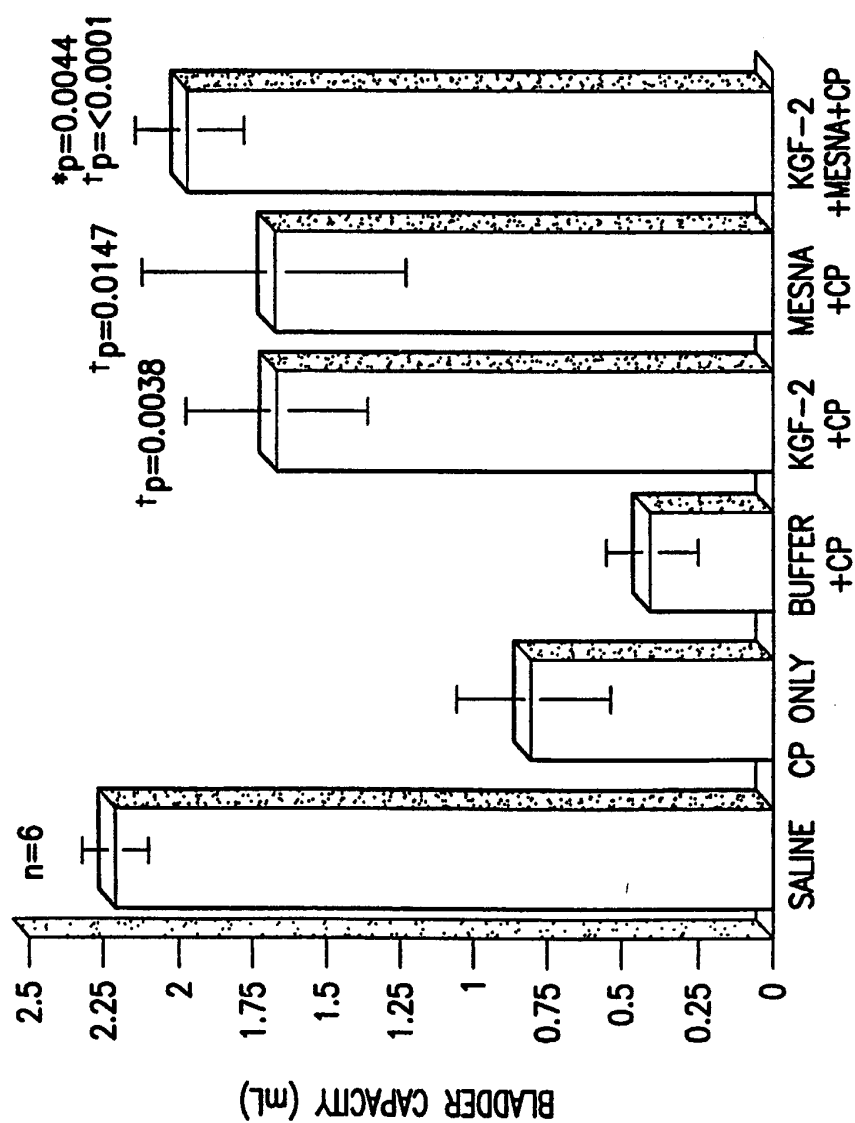


FIG.53

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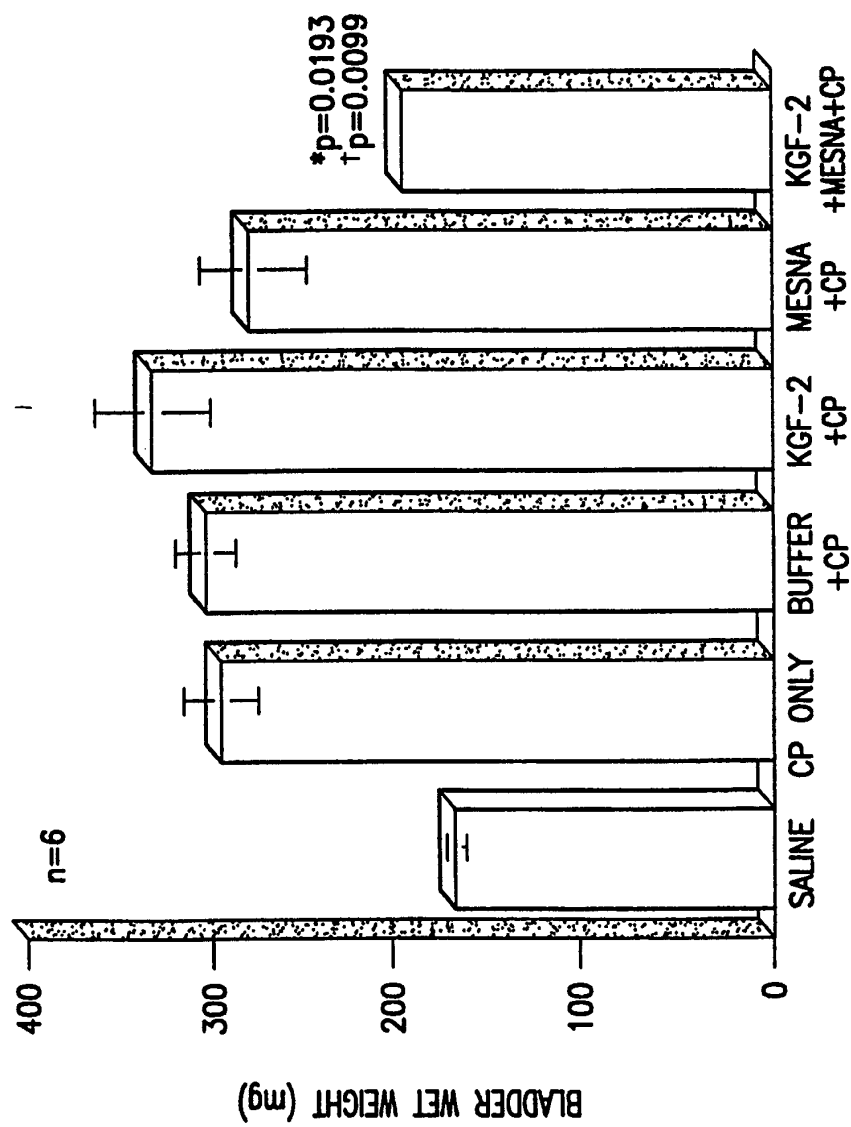


FIG.54

-1-

SEQUENCE LISTING

<110> Human Genome Sciences, Inc.

Jimenez, Pablo

Rampy, Mark A.

Mendrick, Donna

Russell, Deborah

Louie, Arthur

<120> Therapeutic Uses of Keratinocyte Growth Factor-2

<130> 1488.106PC02

<140>

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<150> US 60/114,387

<151> 30-DEC-1998

<150> US 60/074,585

<151> 13-FEB-1998

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1				5					10				15			

ccc	ggc	tgc	tgc	tgc	tgc	tgc	ttt	ttg	ttg	ctg	ttc	ttg	gtg	tct	tcc	96
Pro	Gly	Cys	Cys	Cys	Cys	Cys	Phe	Leu	Leu	Leu	Phe	Leu	Val	Ser	Ser	
			20					25					30			

gtc	cct	gtc	acc	tgc	caa	gcc	ctt	ggt	cag	gac	atg	gtg	tca	cca	gag	144
Val	Pro	Val	Thr	Cys	Gln	Ala	Leu	Gly	Gln	Asp	Met	Val	Ser	Pro	Glu	
			35				40					45				

gcc	acc	aac	tct	tct	tcc	tcc	tcc	ttc	tcc	tct	cct	tcc	agc	gcg	gga	192
Ala	Thr	Asn	Ser	Ser	Ser	Ser	Ser	Phe	Ser	Ser	Pro	Ser	Ser	Ala	Gly	
			50				55				60					

agg	cat	gtg	cgg	agc	tac	aat	cac	ctt	caa	gga	gat	gtc	cgc	tgg	aga	240
Arg	His	Val	Arg	Ser	Tyr	Asn	His	Leu	Gln	Gly	Asp	Val	Arg	Trp	Arg	

-2-

65	70	75	80	
aag cta ttc tct ttc acc aag tac ttt ctc aag att gag aag aac ggg				288
Lys Leu Phe Ser Phe Thr Lys Tyr Phe Leu Lys Ile Glu Lys Asn Gly				
	85	90	95	
aag gtc agc ggg acc aag aag gag aac tgc ccg tac agc atc ctg gag				336
Lys Val Ser Gly Thr Lys Lys Glu Asn Cys Pro Tyr Ser Ile Leu Glu				
	100	105	110	
ata aca tca gta gaa atc gga gtt gtt gcc gtc aaa gcc att aac agc				384
Ile Thr Ser Val Glu Ile Gly Val Val Ala Val Lys Ala Ile Asn Ser				
	115	120	125	
aac tat tac tta gcc atg aac aag aag ggg aaa ctc tat ggc tca aaa				432
Asn Tyr Tyr Leu Ala Met Asn Lys Lys Gly Lys Leu Tyr Gly Ser Lys				
	130	135	140	
gaa ttt aac aat gac tgt aag ctg aag gag agg ata gag gaa aat gga				480
Glu Phe Asn Asn Asp Cys Lys Leu Lys Glu Arg Ile Glu Glu Asn Gly				
	145	150	155	160
tac aat acc tat gca tca ttt aac tgg cag cat aat ggg agg caa atg				528
Tyr Asn Thr Tyr Ala Ser Phe Asn Trp Gln His Asn Gly Arg Gln Met				
	165	170	175	
tat gtg gca ttg aat gga aaa gga gct cca agg aga gga cag aaa aca				576
Tyr Val Ala Leu Asn Gly Lys Gly Ala Pro Arg Arg Gly Gln Lys Thr				
	180	185	190	
cga agg aaa aac acc tct gct cac ttt ctt cca atg gtg gta cac tca				624
Arg Arg Lys Asn Thr Ser Ala His Phe Leu Pro Met Val Val His Ser				
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tag				627

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Pro Gly Cys Cys Cys Cys Phe Leu Leu Leu Phe Leu Val Ser Ser
20 25 30

Val Pro Val Thr Cys Gln Ala Leu Gly Gln Asp Met Val Ser Pro Glu
35 40 45

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Ala Thr Asn Ser Ser Ser Ser Ser Phe Ser Ser Pro Ser Ser Ala Gly
 50 55 60

Arg His Val Arg Ser Tyr Asn His Leu Gln Gly Asp Val Arg Trp Arg
 65 70 75 80

Lys Leu Phe Ser Phe Thr Lys Tyr Phe Leu Lys Ile Glu Lys Asn Gly
 85 90 95

Lys Val Ser Gly Thr Lys Lys Glu Asn Cys Pro Tyr Ser Ile Leu Glu
 100 105 110

Ile Thr Ser Val Glu Ile Gly Val Val Ala Val Lys Ala Ile Asn Ser
 115 120 125

Asn Tyr Tyr Leu Ala Met Asn Lys Lys Gly Lys Leu Tyr Gly Ser Lys
 130 135 140

Glu Phe Asn Asn Asp Cys Lys Leu Lys Glu Arg Ile Glu Glu Asn Gly
 145 150 155 160

Tyr Asn Thr Tyr Ala Ser Phe Asn Trp Gln His Asn Gly Arg Gln Met
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Tyr Val Ala Leu Asn Gly Lys Gly Ala Pro Arg Arg Gly Gln Lys Thr
 180 185 190

Arg Arg Lys Asn Thr Ser Ala His Phe Leu Pro Met Val Val His Ser
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<210> 10

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<212> DNA

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<400> 10

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38

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-5-

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 <211> 35
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<400> 12
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 20 25 30

Thr Ala Pro Asn Gly Thr Leu Glu Ala Glu Leu Glu Arg Arg Trp Glu
 35 40 45

Ser Leu Val Ala Leu Ser Leu Ala Arg Leu Pro Val Ala Ala Gln Pro
 50 55 60

Lys Glu Ala Ala Val Gln Ser Gly Ala Gly Asp Tyr Leu Leu Gly Ile
 65 70 75 80

Lys Arg Leu Arg Arg Leu Tyr Cys Asn Val Gly Ile Gly Phe His Leu
 85 90 95

Gln Ala Leu Pro Asp Gly Arg Ile Gly Gly Ala His Ala Asp Thr Arg
 100 105 110

Asp Ser Leu Leu Glu Leu Ser Pro Val Glu Arg Gly Val Val Ser Ile
 115 120 125

Phe Gly Val Ala Ser Arg Phe Phe Val Ala Met Ser Ser Lys Gly Lys
 130 135 140

Leu Tyr Gly Ser Pro Phe Phe Thr Asp Glu Cys Thr Phe Lys Glu Ile
 145 150 155 160

-6-

Leu Leu Pro Asn Asn Tyr Asn Ala Tyr Glu Ser Tyr Lys Tyr Pro Gly
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Met Phe Ile Ala Leu Ser Lys Asn Gly Lys Thr Lys Lys Gly Asn Arg
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Val Ser Pro Thr Met Lys Val Thr His Phe Leu Pro Arg Leu
 195 200 205

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Phe Leu Gly Ile Leu Val Gly Met Val Val Pro Ser Pro Ala Gly Thr
 20 25 30

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 35 40 45

Ser Arg Ser Arg Ala Gly Leu Ala Gly Glu Ile Ala Gly Val Asn Trp
 50 55 60

Glu Ser Gly Tyr Leu Val Gly Ile Lys Arg Gln Arg Arg Leu Tyr Cys
 65 70 75 80

Asn Val Gly Ile Gly Phe His Leu Gln Val Leu Pro Asp Gly Arg Ile
 85 90 95

Ser Gly Thr His Glu Glu Asn Pro Tyr Ser Leu Leu Glu Ile Ser Thr
 100 105 110

Val Glu Arg Gly Val Val Ser Leu Phe Gly Val Arg Ser Ala Leu Phe
 115 120 125

Val Ala Met Asn Ser Lys Gly Arg Leu Tyr Ala Thr Pro Ser Phe Gln
 130 135 140

Glu Glu Cys Lys Phe Arg Glu Thr Leu Leu Pro Asn Asn Tyr Asn Ala
 145 150 155 160

Tyr Glu Ser Asp Leu Tyr Gln Gly Thr Tyr Ile Ala Leu Ser Lys Tyr
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Gly Arg Val Lys Arg Gly Ser Lys Val Ser Pro Ile Met Thr Val Thr
 180 185 190

-7-

His Phe Leu Pro Arg Ile
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20 25 30

Gly Pro Ala Ala Thr Asp Arg Asn Pro Arg Gly Ser Ser Ser Arg Gln
35 40 45

Ser Ser Ser Ser Ala Met Ser Ser Ser Ser Ala Ser Ser Pro Ala
50 55 60

Ala Ser Leu Gly Ser Gln Gly Ser Gly Leu Glu Gln Ser Ser Phe Gln
65 70 75 80

Trp Ser Pro Ser Gly Arg Arg Thr Gly Ser Leu Tyr Cys Arg Val Gly
85 90 95

Ile Gly Phe His Leu Gln Ile Tyr Pro Asp Gly Lys Val Asn Gly Ser
100 105 110

His Glu Ala Asn Met Leu Ser Val Leu Glu Ile Phe Ala Val Ser Gln
115 120 125

Gly Ile Val Gly Ile Arg Gly Val Phe Ser Asn Lys Phe Leu Ala Met
130 135 140

Ser Lys Lys Gly Lys Leu His Ala Ser Ala Lys Phe Thr Asp Asp Cys
145 150 155 160

Lys Phe Arg Glu Arg Phe Gln Glu Asn Ser Tyr Asn Thr Tyr Ala Ser
165 170 175

Ala Ile His Arg Thr Glu Lys Thr Gly Arg Glu Trp Tyr Val Ala Leu
180 185 190

Asn Lys Arg Gly Lys Ala Lys Arg Gly Cys Ser Pro Arg Val Lys Pro
195 200 205

Gln His Ile Ser Thr His Phe Leu Pro Arg Phe Lys Gln Ser Glu Gln
210 215 220

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Pro Glu Leu Ser Phe Thr Val Thr Val Pro Glu Lys Lys Asn Pro Pro
 225 230 235 240

Ser Pro Ile Lys Ser Lys Ile Pro Leu Ser Ala Pro Arg Lys Asn Thr
 245 250 255

Asn Ser Val Lys Tyr Arg Leu Lys Phe Arg Phe Gly
 260 265

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<211> 155

<212> PRT

<213> Homo sapiens

<400> 16

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Asn Leu Pro Pro Gly Asn Tyr Lys Lys Pro Lys Leu Leu Tyr Cys Ser
 20 25 30

Asn Gly Gly His Phe Leu Arg Ile Leu Pro Asp Gly Thr Val Asp Gly
 35 40 45

Thr Arg Asp Arg Ser Asp Gln His Ile Gln Leu Gln Leu Ser Ala Glu
 50 55 60

Ser Val Gly Glu Val Tyr Ile Lys Ser Thr Glu Thr Gly Gln Tyr Leu
 65 70 75 80

Ala Met Asp Thr Asp Gly Leu Leu Tyr Gly Ser Gln Thr Pro Asn Glu
 85 90 95

Glu Cys Leu Phe Leu Glu Arg Leu Glu Glu Asn His Tyr Asn Thr Tyr
 100 105 110

Ile Ser Lys Lys His Ala Glu Lys Asn Trp Phe Val Gly Leu Lys Lys
 115 120 125

Asn Gly Ser Cys Lys Arg Gly Pro Arg Thr His Tyr Gly Gln Lys Ala
 130 135 140

Ile Leu Phe Leu Pro Leu Pro Val Ser Ser Asp
 145 150 155

<210> 17

<211> 155

<212> PRT

<213> Homo sapiens

-9-

<400> 17

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 1 5 10 15

Gly Ser Gly Ala Phe Pro Pro Gly His Phe Lys Asp Pro Lys Arg Leu
 20 25 30

Tyr Cys Lys Asn Gly Gly Phe Phe Leu Arg Ile His Pro Asp Gly Arg
 35 40 45

Val Asp Gly Val Arg Glu Lys Ser Asp Pro His Ile Lys Leu Gln Leu
 50 55 60

Gln Ala Glu Glu Arg Gly Val Val Ser Ile Lys Gly Val Cys Ala Asn
 65 70 75 80

Arg Tyr Leu Ala Met Lys Glu Asp Gly Arg Leu Leu Ala Ser Lys Cys
 85 90 95

Val Thr Asp Glu Cys Phe Phe Phe Glu Arg Leu Glu Ser Asn Asn Tyr
 100 105 110

Asn Thr Tyr Arg Ser Arg Lys Tyr Thr Ser Trp Tyr Val Ala Leu Lys
 115 120 125

Arg Thr Gly Gln Tyr Lys Leu Gly Ser Lys Thr Gly Pro Gly Gln Lys
 130 135 140

Ala Ile Leu Phe Leu Pro Met Ser Ala Lys Ser
 145 150 155

<210> 18

<211> 208

<212> PRT

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<400> 18

Met Ala Pro Leu Gly Glu Val Gly Asn Tyr Phe Gly Val Gln Asp Ala
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Val Pro Phe Gly Asn Val Pro Val Leu Pro Val Asp Ser Pro Val Leu
 20 25 30

Leu Ser Asp His Leu Gly Gln Ser Glu Ala Gly Gly Leu Pro Arg Gly
 35 40 45

Pro Ala Val Thr Asp Leu Asp His Leu Lys Gly Ile Leu Arg Arg Arg
 50 55 60

Gln Leu Tyr Cys Arg Thr Gly Phe His Leu Glu Ile Phe Pro Asn Gly

-10-

65		70		75		80									
Thr	Ile	Gln	Gly	Thr	Arg	Lys	Asp	His	Ser	Arg	Phe	Gly	Ile	Leu	Glu
				85					90					95	
Phe	Ile	Ser	Ile	Ala	Val	Gly	Leu	Val	Ser	Ile	Arg	Gly	Val	Asp	Ser
			100					105					110		
Gly	Leu	Tyr	Leu	Gly	Met	Asn	Glu	Lys	Gly	Glu	Leu	Tyr	Gly	Ser	Glu
		115					120					125			
Lys	Leu	Thr	Gln	Glu	Cys	Val	Phe	Arg	Glu	Gln	Phe	Glu	Glu	Asn	Trp
		130					135				140				
Tyr	Asn	Thr	Tyr	Ser	Ser	Asn	Leu	Tyr	Lys	His	Val	Asp	Thr	Gly	Arg
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Arg	Tyr	Tyr	Val	Ala	Leu	Asn	Lys	Asp	Gly	Thr	Pro	Arg	Glu	Gly	Thr
			165						170					175	
Arg	Thr	Lys	Arg	His	Gln	Lys	Phe	Thr	His	Phe	Leu	Pro	Arg	Pro	Val
		180						185					190		
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<212> PRT

<213> Homo sapiens

<400> 19

Met	His	Lys	Trp	Ile	Leu	Thr	Trp	Ile	Leu	Pro	Thr	Leu	Leu	Tyr	Arg
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Ser	Cys	Phe	His	Ile	Ile	Cys	Leu	Val	Gly	Thr	Ile	Ser	Leu	Ala	Cys
			20						25				30		

Asn	Asp	Met	Thr	Pro	Glu	Gln	Met	Ala	Thr	Asn	Val	Asn	Cys	Ser	Ser
		35					40						45		

Pro	Glu	Arg	His	Thr	Arg	Ser	Tyr	Asp	Tyr	Met	Glu	Gly	Gly	Asp	Ile
	50					55					60				

Arg	Val	Arg	Arg	Leu	Phe	Cys	Arg	Thr	Gln	Trp	Tyr	Leu	Arg	Ile	Asp
65					70					75				80	

Lys	Arg	Gly	Lys	Val	Lys	Gly	Thr	Gln	Glu	Met	Lys	Asn	Asn	Tyr	Asn
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

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	85		90		95
Ile Met Glu Ile Arg Thr Val Ala Val Gly Ile Val Ala Ile Lys Gly	100		105		110
Val Glu Ser Glu Phe Tyr Leu Ala Met Asn Lys Glu Gly Lys Leu Tyr	115		120		125
Ala Lys Lys Glu Cys Asn Glu Asp Cys Asn Phe Lys Glu Leu Ile Leu	130		135		140
Glu Asn His Tyr Asn Thr Tyr Ala Ser Ala Lys Trp Thr His Asn Gly	145		150		155
					160
Gly Glu Met Phe Val Ala Leu Asn Gln Lys Gly Ile Pro Val Arg Gly	165		170		175
Lys Lys Thr Lys Lys Glu Gln Lys Thr Ala His Phe Leu Pro Met Ala	180		185		190

Ile Thr

<210> 20

<211> 208

<212> PRT

<213> Homo sapiens

<400> 20

Met Trp Lys Trp Ile Leu Thr His Cys Ala Ser Ala Phe Pro His Leu	1	5	10	15
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Pro Gly Cys Cys Cys Cys Phe Leu Leu Leu Phe Leu Val Ser Ser	20	25	30
---	----	----	----

Val Pro Val Thr Cys Gln Ala Leu Gly Gln Asp Met Val Ser Pro Glu	35	40	45
---	----	----	----

Ala Thr Asn Ser Ser Ser Ser Ser Phe Ser Ser Pro Ser Ser Ala Gly	50	55	60
---	----	----	----

Arg His Val Arg Ser Tyr Asn His Leu Gln Gly Asp Val Arg Trp Arg	65	70	75	80
---	----	----	----	----

Lys Leu Phe Ser Phe Thr Lys Tyr Phe Leu Lys Ile Glu Lys Asn Gly	85	90	95
---	----	----	----

Lys Val Ser Gly Thr Lys Lys Glu Asn Cys Pro Tyr Ser Ile Leu Glu	100	105	110
---	-----	-----	-----

Ile Thr Ser Val Glu Ile Gly Val Val Ala Val Lys Ala Ile Asn Ser

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115	120	125
Asn Tyr Tyr Leu Ala Met	Asn Lys Lys Gly Lys	Leu Tyr Gly Ser Lys
130	135	140
Glu Phe Asn Asn Asp Cys	Lys Leu Lys Glu Arg	Ile Glu Glu Asn Gly
145	150	155 160
Tyr Asn Thr Tyr Ala Ser	Phe Asn Trp Gln His	Asn Gly Arg Gln Met
	165	170 175
Tyr Val Ala Leu Asn Gly	Lys Gly Ala Pro Arg	Arg Gly Gln Lys Thr
	180 185	190
Arg Arg Lys Asn Thr Ser	Ala His Phe Leu Pro	Met Val Val His Ser
	195 200	205

<210> 21

<211> 239

<212> PRT

<213> Homo sapiens

<400> 21

Met Gly Leu Ile Trp	Leu Leu Leu Leu Ser	Leu Leu Glu Pro Gly Trp
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Pro Ala Ala Gly	Pro Gly Ala Arg	Leu Arg Arg Asp Ala Gly Gly Arg
	20	25 30
Gly Gly Val Tyr	Glu His Leu Gly	Gly Ala Pro Arg Arg Arg Lys Leu
	35	40 45
Tyr Cys Ala Thr	Lys Tyr His Leu	Gln Leu His Pro Ser Gly Arg Val
	50	55 60
Asn Gly Ser Leu	Glu Asn Ser Ala Tyr	Ser Ile Leu Glu Ile Thr Ala
	65	70 75 80
Val Glu Val Gly	Ile Val Ala Ile Arg	Gly Leu Phe Ser Gly Arg Tyr
	85	90 95
Leu Ala Met Asn	Lys Arg Gly Arg	Leu Tyr Ala Ser Glu His Tyr Ser
	100	105 110
Ala Glu Cys Glu	Phe Val Glu Arg	Ile His Glu Leu Gly Tyr Asn Thr
	115	120 125
Tyr Ala Ser Arg	Leu Tyr Arg Thr	Val Ser Ser Thr Pro Gly Ala Arg

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130 135 140
 Arg Gln Pro Ser Ala Glu Arg Leu Trp Tyr Val Ser Val Asn Gly Lys
 145 150 155 160
 Gly Arg Pro Arg Arg Gly Phe Lys Thr Arg Arg Thr Gln Lys Ser Ser
 165 170 175
 Leu Phe Leu Pro Arg Val Leu Asp His Arg Asp His Glu Met Val Arg
 180 185 190
 Gln Leu Gln Ser Gly Leu Pro Arg Pro Pro Gly Lys Gly Val Gln Pro
 195 200 205
 Arg Arg Arg Arg Gln Lys Gln Ser Pro Asp Asn Leu Glu Pro Ser His
 210 215 220
 Val Gln Ala Ser Arg Leu Gly Ser Gln Leu Glu Ala Ser Ala His
 225 230 235

 <210> 22
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 <212> PRT
 <213> Homo sapiens

 <400> 22
 Met Gly Ser Pro Arg Ser Ala Leu Ser Cys Leu Leu Leu His Leu Leu
 1 5 10 15
 Val Leu Cys Leu Gln Ala Gln Val Arg Ser Ala Ala Gln Lys Arg Gly
 20 25 30
 Pro Gly Ala Gly Asn Pro Ala Asp Thr Leu Gly Gln Gly His Glu Asp
 35 40 45
 Arg Pro Phe Gly Gln Arg Ser Arg Ala Gly Lys Asn Phe Thr Asn Pro
 50 55 60
 Ala Pro Asn Tyr Pro Glu Glu Gly Ser Lys Glu Gln Arg Asp Ser Val
 65 70 75 80
 Leu Pro Lys Val Thr Gln Arg His Val Arg Glu Gln Ser Leu Val Thr
 85 90 95
 Asp Gln Leu Ser Arg Arg Leu Ile Arg Thr Tyr Gln Leu Tyr Ser Arg
 100 105 110
 Thr Ser Gly Lys His Val Gln Val Leu Ala Asn Lys Arg Ile Asn Ala
 115 120 125
 Met Ala Glu Asp Gly Asp Pro Phe Ala Lys Leu Ile Val Glu Thr Asp

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130	135	140
Thr Phe Gly Ser Arg Val Arg Val Arg Gly Ala Glu Thr Gly Leu Tyr		
145	150	155 160
Ile Cys Met Asn Lys Lys Gly Lys Leu Ile Ala Lys Ser Asn Gly Lys		
	165	170 175
Gly Lys Asp Cys Val Phe Thr Glu Ile Val Leu Glu Asn Asn Tyr Thr		
	180	185 190
Ala Leu Gln Asn Ala Lys Tyr Glu Gly Trp Tyr Met Ala Phe Thr Arg		
	195	200 205
Lys Gly Arg Pro Arg Lys Gly Ser Lys Thr Arg Gln His Gln Arg Glu		
	210	215 220
Val His Phe Met Lys Arg Leu Pro Arg Gly His His Thr Thr Glu Gln		
	225	230 235 240
Ser Leu Arg Phe Glu Phe Leu Asn Tyr Pro Pro Phe Thr Arg Ser Leu		
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Arg Gly Ser Gln Arg Thr Trp Ala Pro Glu Pro Arg		
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<210> 23

<211> 4177

<212> DNA

<213> Homo sapiens

<220>

<221> CDS

<222> (593)..(1216)

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Met Trp

1

aaa tgg ata ctg aca cat tgt gcc tca gcc ttt ccc cac ctg ccc ggc 646

Lys Trp Ile Leu Thr His Cys Ala Ser Ala Phe Pro His Leu Pro Gly

5

10

15

tgc tgc tgc tgc tgc ttt ttg ttg ctg ttc ttg gtg tct tcc gtc cct 694

Cys Cys Cys Cys Cys Phe Leu Leu Leu Phe Leu Val Ser Ser Val Pro

20

25

30

gtc acc tgc caa gcc ctt ggt cag gac atg gtg tca cca gag gcc acc 742

Val Thr Cys Gln Ala Leu Gly Gln Asp Met Val Ser Pro Glu Ala Thr

35

40

45

50

aac tct tct tcc tcc tcc ttc tcc tct cct tcc agc gcg gga agg cat 790

Asn Ser Ser Ser Ser Phe Ser Ser Pro Ser Ser Ala Gly Arg His

55

60

65

gtg cgg agc tac aat cac ctt caa gga gat gtc cgc tgg aga aag cta 838

Val Arg Ser Tyr Asn His Leu Gln Gly Asp Val Arg Trp Arg Lys Leu

70

75

80

ttc tct ttc acc aag tac ttt ctc aag att gag aag aac ggg aag gtc 886

Phe Ser Phe Thr Lys Tyr Phe Leu Lys Ile Glu Lys Asn Gly Lys Val

85

90

95

agc ggg acc aag aag gag aac tgc ccg tac agc atc ctg gag ata aca 934

Ser Gly Thr Lys Lys Glu Asn Cys Pro Tyr Ser Ile Leu Glu Ile Thr

100

105

110

tca gta gaa atc gga gtt gtt gcc gtc aaa gcc att aac agc aac tat 982

Ser Val Glu Ile Gly Val Val Ala Val Lys Ala Ile Asn Ser Asn Tyr

115

120

125

130

tac tta gcc atg aac aag aag ggg aaa ctc tat ggc tca aaa gaa ttt 1030

Tyr Leu Ala Met Asn Lys Lys Gly Lys Leu Tyr Gly Ser Lys Glu Phe

135

140

145

aac aat gac tgt aag ctg aag gag agg ata gag gaa aat gga tac aat 1078

Asn Asn Asp Cys Lys Leu Lys Glu Arg Ile Glu Glu Asn Gly Tyr Asn

150

155

160

acc tat gca tca ttt aac tgg cag cat aat ggg agg caa atg tat gtg 1126

Thr Tyr Ala Ser Phe Asn Trp Gln His Asn Gly Arg Gln Met Tyr Val

165

170

175

gca ttg aat gga aaa gga gct cca agg aga gga cag aaa aca cga agg 1174

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Ala Leu Asn Gly Lys Gly Ala Pro Arg Arg Gly Gln Lys Thr Arg Arg
 180 185 190

aaa aac acc tct gct cac ttt ctt cca atg gtg gta cac tca 1216
 Lys Asn Thr Ser Ala His Phe Leu Pro Met Val Val His Ser

195 200 205

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<211> 208

<212> PRT

<213> Homo sapiens

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Pro Gly Cys Cys Cys Cys Phe Leu Leu Phe Leu Val Ser Ser
 20 25 30

Val Pro Val Thr Cys Gln Ala Leu Gly Gln Asp Met Val Ser Pro Glu
 35 40 45

Ala Thr Asn Ser Ser Ser Ser Phe Ser Ser Pro Ser Ser Ala Gly
 50 55 60

Arg His Val Arg Ser Tyr Asn His Leu Gln Gly Asp Val Arg Trp Arg
 65 70 75 80

Lys Leu Phe Ser Phe Thr Lys Tyr Phe Leu Lys Ile Glu Lys Asn Gly
 85 90 95

Lys Val Ser Gly Thr Lys Lys Glu Asn Cys Pro Tyr Ser Ile Leu Glu
 100 105 110

Ile Thr Ser Val Glu Ile Gly Val Val Ala Val Lys Ala Ile Asn Ser
 115 120 125

Asn Tyr Tyr Leu Ala Met Asn Lys Lys Gly Lys Leu Tyr Gly Ser Lys
 130 135 140

Glu Phe Asn Asn Asp Cys Lys Leu Lys Glu Arg Ile Glu Glu Asn Gly
 145 150 155 160

Tyr Asn Thr Tyr Ala Ser Phe Asn Trp Gln His Asn Gly Arg Gln Met
 165 170 175

Tyr Val Ala Leu Asn Gly Lys Gly Ala Pro Arg Arg Gly Gln Lys Thr
 180 185 190

Arg Arg Lys Asn Thr Ser Ala His Phe Leu Pro Met Val Val His Ser
 195 200 205

<210> 25

<211> 31

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<212> PRT

<213> Homo sapiens

<400> 25

Gly Gln Asp Met Val Ser Pro Glu Ala Thr Asn Ser Ser Ser Ser Ser
 1 5 10 15

Phe Ser Ser Pro Ser Ser Ala Gly Arg His Val Arg Ser Tyr Asn
 20 25 30

<210> 26

<211> 19

<212> PRT

<213> Homo sapiens

<400> 26

Lys Ile Glu Lys Asn Gly Lys Val Ser Gly Thr Lys Lys Glu Asn Cys
 1 5 10 15

Pro Tyr Ser

<210> 27

<211> 30

<212> PRT

<213> Homo sapiens

<400> 27

Asn Lys Lys Gly Lys Leu Tyr Gly Ser Lys Glu Phe Asn Asn Asp Cys
 1 5 10 15

Lys Leu Lys Glu Arg Ile Glu Glu Asn Gly Tyr Asn Thr Tyr
 20 25 30

<210> 28

<211> 19

<212> PRT

<213> Homo sapiens

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Asn Gly Lys Gly Ala Pro Arg Arg Gly Gln Lys Thr Arg Arg Lys Asn
 1 5 10 15

Thr Ser Ala

<210> 29

<211> 555

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<212> DNA

<213> Homo sapiens

<220>

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<222> (1)..(552)

<400> 29

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   1               5               10               15

ggt cag gac atg gtt tct ccg gaa gct acc aac tct tcc tct tcc tct      96
Gly Gln Asp Met Val Ser Pro Glu Ala Thr Asn Ser Ser Ser Ser Ser
           20               25               30

ttc tct tcc ccg tct tcc gct ggt cgt cac gtt cgt tct tac aac cac      144
Phe Ser Ser Pro Ser Ser Ala Gly Arg His Val Arg Ser Tyr Asn His
           35               40               45

ctg cag ggt gac gtt cgt tgg cgt aaa ctg ttc tct ttc acc aaa tac      192
Leu Gln Gly Asp Val Arg Trp Arg Lys Leu Phe Ser Phe Thr Lys Tyr
           50               55               60

ttc ctg aaa atc gaa aaa aac ggt aaa gtt tct ggg acc aag aag gag      240
Phe Leu Lys Ile Glu Lys Asn Gly Lys Val Ser Gly Thr Lys Lys Glu
           65               70               75               80

aac tgc ccg tac agc atc ctg gag ata aca tca gta gaa atc gga gtt      288
Asn Cys Pro Tyr Ser Ile Leu Glu Ile Thr Ser Val Glu Ile Gly Val
           85               90               95

gtt gcc gtc aaa gcc att aac agc aac tat tac tta gcc atg aac aag      336
Val Ala Val Lys Ala Ile Asn Ser Asn Tyr Tyr Leu Ala Met Asn Lys
           100              105              110

aag ggg aaa ctc tat ggc tca aaa gaa ttt aac aat gac tgt aag ctg      384
Lys Gly Lys Leu Tyr Gly Ser Lys Glu Phe Asn Asn Asp Cys Lys Leu
           115              120              125

aag gag agg ata gag gaa aat gga tac aat acc tat gca tca ttt aac      432
Lys Glu Arg Ile Glu Glu Asn Gly Tyr Asn Thr Tyr Ala Ser Phe Asn
           130              135              140

tgg cag cat aat ggg agg caa atg tat gtg gca ttg aat gga aaa gga      480
Trp Gln His Asn Gly Arg Gln Met Tyr Val Ala Leu Asn Gly Lys Gly
           145              150              155              160

gct cca agg aga gga cag aaa aca cga agg aaa aac acc tct gct cac      528
Ala Pro Arg Arg Gly Gln Lys Thr Arg Arg Lys Asn Thr Ser Ala His
           165              170              175

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-21-

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 180

555

<210> 30
 <211> 184
 <212> PRT
 <213> Homo sapiens

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 1 5 10 15

Gly Gln Asp Met Val Ser Pro Glu Ala Thr Asn Ser Ser Ser Ser Ser
 20 25 30

Phe Ser Ser Pro Ser Ser Ala Gly Arg His Val Arg Ser Tyr Asn His
 35 40 45

Leu Gln Gly Asp Val Arg Trp Arg Lys Leu Phe Ser Phe Thr Lys Tyr
 50 55 60

Phe Leu Lys Ile Glu Lys Asn Gly Lys Val Ser Gly Thr Lys Lys Glu
 65 70 75 80

Asn Cys Pro Tyr Ser Ile Leu Glu Ile Thr Ser Val Glu Ile Gly Val
 85 90 95

Val Ala Val Lys Ala Ile Asn Ser Asn Tyr Tyr Leu Ala Met Asn Lys
 100 105 110

Lys Gly Lys Leu Tyr Gly Ser Lys Glu Phe Asn Asn Asp Cys Lys Leu
 115 120 125

Lys Glu Arg Ile Glu Glu Asn Gly Tyr Asn Thr Tyr Ala Ser Phe Asn
 130 135 140

Trp Gln His Asn Gly Arg Gln Met Tyr Val Ala Leu Asn Gly Lys Gly
 145 150 155 160

Ala Pro Arg Arg Gly Gln Lys Thr Arg Arg Lys Asn Thr Ser Ala His
 165 170 175

Phe Leu Pro Met Val Val His Ser
 180

<210> 31
 <211> 84
 <212> DNA
 <213> Homo sapiens

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<400> 31
atgtggaaat ggatactgac ccactgcgct tctgctttcc cgcacctgcc gggttgctgc 60

tgctgctgct tctgctgct gtcc 84

<210> 32
<211> 82
<212> DNA
<213> Homo sapiens

<400> 32
ccggagaaac catgtcctga ccagagcct ggcaggtaac cggaacagaa gaaaccagga 60

acagcagcag gaagcagcag ca 82

<210> 33
<211> 80
<212> DNA
<213> Homo sapiens

<400> 33
gggtcaggac atggtttctc cggaagctac caactcttct tcttcttctt tcttcttctc 60

gtcttctgct ggctcgtcacg 80

<210> 34
<211> 81
<212> DNA
<213> Homo sapiens

<400> 34
ggtgaaagag aacagtttac gccaacgaac gtcaccctgc aggtggttgt aagaacgaac 60

gtgacgacca gcagaagacg g 81

<210> 35
<211> 75
<212> DNA
<213> Homo sapiens

<400> 35
cgttggcgta aactgttctc tttcaccaaa tacttctga aaatcgaaaa aaacggtaaa 60

gtttctggga ccaaa 75

<210> 36

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<211> 39
 <212> DNA
 <213> Homo sapiens

<400> 36
 tttggtccca gaaactttac cgtttttttc gatttttcag 39

<210> 37
 <211> 36
 <212> DNA
 <213> Homo sapiens

<400> 37
 aaaggatcca tgtggaaatg gatactgacc cactgc 36

<210> 38
 <211> 627
 <212> DNA
 <213> Homo sapiens

<220>
 <221> CDS
 <222> (1)..(624)

<400> 38
 atg tgg aaa tgg ata ctg acc cac tgc gct tct gct ttc ccg cac ctg 48
 Met Trp Lys Trp Ile Leu Thr His Cys Ala Ser Ala Phe Pro His Leu
 1 5 10 15

ccg ggt tgc tgc tgc tgc tgc ttc ctg ctg ctg ttc ctg gtt tct tct 96
 Pro Gly Cys Cys Cys Cys Cys Phe Leu Leu Leu Phe Leu Val Ser Ser
 20 25 30

gtt ccg gtt acc tgc cag gct ctg ggt cag gac atg gtt tct ccg gaa 144
 Val Pro Val Thr Cys Gln Ala Leu Gly Gln Asp Met Val Ser Pro Glu
 35 40 45

gct acc aac tct tcc tct tcc tct ttc tct tcc ccg act tcc gct ggt 192
 Ala Thr Asn Ser Ser Ser Ser Ser Phe Ser Ser Pro Thr Ser Ala Gly
 50 55 60

cgt cac gtt cgt tct tac aac cac ctg cag ggt gac gtt cgt tgg cgt 240
 Arg His Val Arg Ser Tyr Asn His Leu Gln Gly Asp Val Arg Trp Arg
 65 70 75 80

aaa ctg ttc tct ttc acc aaa tac ttc ctg aaa atc gaa aaa aac ggt 288
 Lys Leu Phe Ser Phe Thr Lys Tyr Phe Leu Lys Ile Glu Lys Asn Gly
 85 90 95

aaa gtt tct ggg acc aag aag gag aac tgc ccg tac agc atc ctg gag 336

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Lys Val Ser Gly Thr Lys Lys Glu Asn Cys Pro Tyr Ser Ile Leu Glu
 100 105 110
 ata aca tca gta gaa atc gga gtt gtt gcc gtc aaa gcc att aac agc 384
 Ile Thr Ser Val Glu Ile Gly Val Val Ala Val Lys Ala Ile Asn Ser
 115 120 125
 aac tat tac tta gcc atg aac aag aag ggg aaa ctc tat ggc tca aaa 432
 Asn Tyr Tyr Leu Ala Met Asn Lys Lys Gly Lys Leu Tyr Gly Ser Lys
 130 135 140
 gaa ttt aac aat gac tgt aag ctg aag gag agg ata gag gaa aat gga 480
 Glu Phe Asn Asn Asp Cys Lys Leu Lys Glu Arg Ile Glu Glu Asn Gly
 145 150 155 160
 tac aat acc tat gca tca ttt aac tgg cag cat aat ggg agg caa atg 528
 Tyr Asn Thr Tyr Ala Ser Phe Asn Trp Gln His Asn Gly Arg Gln Met
 165 170 175
 tat gtg gca ttg aat gga aaa gga gct cca agg aga gga cag aaa aca 576
 Tyr Val Ala Leu Asn Gly Lys Gly Ala Pro Arg Arg Gly Gln Lys Thr
 180 185 190
 cga agg aaa aac acc tct gct cac ttt ctt cca atg gtg gta cac tca 624
 Arg Arg Lys Asn Thr Ser Ala His Phe Leu Pro Met Val Val His Ser
 195 200 205
 tag 627

<210> 39
 <211> 208
 <212> PRT
 <213> Homo sapiens

<400> 39
 Met Trp Lys Trp Ile Leu Thr His Cys Ala Ser Ala Phe Pro His Leu
 1 5 10 15
 Pro Gly Cys Cys Cys Cys Cys Phe Leu Leu Leu Phe Leu Val Ser Ser
 20 25 30
 Val Pro Val Thr Cys Gln Ala Leu Gly Gln Asp Met Val Ser Pro Glu
 35 40 45
 Ala Thr Asn Ser Ser Ser Ser Ser Phe Ser Ser Pro Thr Ser Ala Gly
 50 55 60
 Arg His Val Arg Ser Tyr Asn His Leu Gln Gly Asp Val Arg Trp Arg
 65 70 75 80
 Lys Leu Phe Ser Phe Thr Lys Tyr Phe Leu Lys Ile Glu Lys Asn Gly

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	85		90		95
Lys Val Ser Gly Thr Lys Lys Glu Asn Cys Pro Tyr Ser Ile Leu Glu					
	100		105		110
Ile Thr Ser Val Glu Ile Gly Val Val Ala Val Lys Ala Ile Asn Ser					
	115		120		125
Asn Tyr Tyr Leu Ala Met Asn Lys Lys Gly Lys Leu Tyr Gly Ser Lys					
	130		135		140
Glu Phe Asn Asn Asp Cys Lys Leu Lys Glu Arg Ile Glu Glu Asn Gly					
	145		150		155
					160
Tyr Asn Thr Tyr Ala Ser Phe Asn Trp Gln His Asn Gly Arg Gln Met					
	165		170		175
Tyr Val Ala Leu Asn Gly Lys Gly Ala Pro Arg Arg Gly Gln Lys Thr					
	180		185		190
Arg Arg Lys Asn Thr Ser Ala His Phe Leu Pro Met Val Val His Ser					
	195		200		205

<210> 40

<211> 38

<212> DNA

<213> Homo sapiens

<400> 40

tttcatgact tgtcaagctc tgggtcaaga tatggttc

38

<210> 41

<211> 28

<212> DNA

<213> Homo sapiens

<400> 41

gccaagctt ccacaaacgt tgccttcc

28

<210> 42

<211> 525

<212> DNA

<213> Homo sapiens

<220>

<221> CDS

<222> (1)..(522)

<400> 42

-26-

atg acc tgc cag gct ctg ggt cag gac atg gtt tct ccg gaa gct acc 48
 Met Thr Cys Gln Ala Leu Gly Gln Asp Met Val Ser Pro Glu Ala Thr
 1 5 10 15
 aac tct tcc tct tcc tct ttc tct tcc ccg tct tcc gct ggt cgt cac 96
 Asn Ser Ser Ser Ser Ser Phe Ser Ser Pro Ser Ser Ala Gly Arg His
 20 25 30
 gtt cgt tct tac aac cac ctg cag ggt gac gtt cgt tgg cgt aaa ctg 144
 Val Arg Ser Tyr Asn His Leu Gln Gly Asp Val Arg Trp Arg Lys Leu
 35 40 45
 ttc tct ttc acc aaa tac ttc ctg aaa atc gaa aaa aac ggt aaa gtt 192
 Phe Ser Phe Thr Lys Tyr Phe Leu Lys Ile Glu Lys Asn Gly Lys Val
 50 55 60
 tct ggg acc aag aag gag aac tgc ccg tac agc atc ctg gag ata aca 240
 Ser Gly Thr Lys Lys Glu Asn Cys Pro Tyr Ser Ile Leu Glu Ile Thr
 65 70 75 80
 tca gta gaa atc gga gtt gtt gcc gtc aaa gcc att aac agc aac tat 288
 Ser Val Glu Ile Gly Val Val Ala Val Lys Ala Ile Asn Ser Asn Tyr
 85 90 95
 tac tta gcc atg aac aag aag ggg aaa ctc tat ggc tca aaa gaa ttt 336
 Tyr Leu Ala Met Asn Lys Lys Gly Lys Leu Tyr Gly Ser Lys Glu Phe
 100 105 110
 aac aat gac tgt aag ctg aag gag agg ata gag gaa aat gga tac aat 384
 Asn Asn Asp Cys Lys Leu Lys Glu Arg Ile Glu Glu Asn Gly Tyr Asn
 115 120 125
 acc tat gca tca ttt aac tgg cag cat aat ggg agg caa atg tat gtg 432
 Thr Tyr Ala Ser Phe Asn Trp Gln His Asn Gly Arg Gln Met Tyr Val
 130 135 140
 gca ttg aat gga aaa gga gct cca agg aga gga cag aaa aca cga agg 480
 Ala Leu Asn Gly Lys Gly Ala Pro Arg Arg Gly Gln Lys Thr Arg Arg
 145 150 155 160
 aaa aac acc tct gct cac ttt ctt cca atg gtg gta cac tca tag 525
 Lys Asn Thr Ser Ala His Phe Leu Pro Met Val Val His Ser
 165 170

<210> 43

<211> 174

<212> PRT

<213> Homo sapiens

<400> 43

Met Thr Cys Gln Ala Leu Gly Gln Asp Met Val Ser Pro Glu Ala Thr

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1	5	10	15
Asn Ser Ser Ser Ser Ser Phe Ser Ser Pro Ser Ser Ala Gly Arg His	20	25	30
Val Arg Ser Tyr Asn His Leu Gln Gly Asp Val Arg Trp Arg Lys Leu	35	40	45
Phe Ser Phe Thr Lys Tyr Phe Leu Lys Ile Glu Lys Asn Gly Lys Val	50	55	60
Ser Gly Thr Lys Lys Glu Asn Cys Pro Tyr Ser Ile Leu Glu Ile Thr	65	70	75
Ser Val Glu Ile Gly Val Val Ala Val Lys Ala Ile Asn Ser Asn Tyr	85	90	95
Tyr Leu Ala Met Asn Lys Lys Gly Lys Leu Tyr Gly Ser Lys Glu Phe	100	105	110
Asn Asn Asp Cys Lys Leu Lys Glu Arg Ile Glu Glu Asn Gly Tyr Asn	115	120	125
Thr Tyr Ala Ser Phe Asn Trp Gln His Asn Gly Arg Gln Met Tyr Val	130	135	140
Ala Leu Asn Gly Lys Gly Ala Pro Arg Arg Gly Gln Lys Thr Arg Arg	145	150	155
Lys Asn Thr Ser Ala His Phe Leu Pro Met Val Val His Ser	165	170	

<210> 44

<211> 45

<212> DNA

<213> Homo sapiens

<400> 44

tcagtgaatt cattaaagag gagaaattaa tcatgacttg ccagg

45

<210> 45

<211> 48

<212> DNA

<213> Homo sapiens

<400> 45

tcatgacttg ccaggcactg ggtcaagaca tggtttcccc ggaagcta

48

<210> 46

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<211> 48
<212> DNA
<213> Homo sapiens

<400> 46
gcttcagcag cccatctagc gcaggtcgtc acgttcgctc ttacaacc 48

<210> 47
<211> 48
<212> DNA
<213> Homo sapiens

<400> 47
gttcggtggc gcaaactggt cagctttacc aagtacttcc tgaaaatc 48

<210> 48
<211> 28
<212> DNA
<213> Homo sapiens

<400> 48
tcgaaaaaaaa cggtaaagtt tctgggac 28

<210> 49
<211> 48
<212> DNA
<213> Homo sapiens

<400> 49
gatgggctgc tgaagctaga gctggagctg ttggtagctt ccggggaa 48

<210> 50
<211> 45
<212> DNA
<213> Homo sapiens

<400> 50
aacagtttgc gccaacgaac atcaccctgt aagtggttgt aagag 45

<210> 51
<211> 47
<212> DNA
<213> Homo sapiens

<400> 51
ttcttgggtcc cagaaacttt accgtttttt tcgattttca ggaagta 47

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<210> 52
 <211> 24
 <212> DNA
 <213> Homo sapiens

<400> 52
 ttcttgggtcc cagaaacttt accg 24

<210> 53
 <211> 45
 <212> DNA
 <213> Homo sapiens

<400> 53
 agatcaggct tctattatta tgagtgtacc accattggaa gaaag 45

<210> 54
 <211> 525
 <212> DNA
 <213> Homo sapiens

<220>
 <221> CDS
 <222> (1)..(522)

<400> 54
 atg act tgc cag gca ctg ggt caa gac atg gtt tcc ccg gaa gct acc 48
 Met Thr Cys Gln Ala Leu Gly Gln Asp Met Val Ser Pro Glu Ala Thr
 1 5 10 15

aac agc tcc agc tct agc ttc agc agc cca tct agc gca ggt cgt cac 96
 Asn Ser Ser Ser Ser Ser Phe Ser Ser Pro Ser Ser Ala Gly Arg His
 20 25 30

gtt cgc tct tac aac cac tta cag ggt gat gtt cgt tgg cgc aaa ctg 144
 Val Arg Ser Tyr Asn His Leu Gln Gly Asp Val Arg Trp Arg Lys Leu
 35 40 45

ttc agc ttt acc aag tac ttc ctg aaa atc gaa aaa aac ggt aaa gtt 192
 Phe Ser Phe Thr Lys Tyr Phe Leu Lys Ile Glu Lys Asn Gly Lys Val
 50 55 60

tct ggg acc aag aag gag aac tgc ccg tac agc atc ctg gag ata aca 240
 Ser Gly Thr Lys Lys Glu Asn Cys Pro Tyr Ser Ile Leu Glu Ile Thr
 65 70 75 80

tca gta gaa atc gga gtt gtt gcc gtc aaa gcc att aac agc aac tat 288
 Ser Val Glu Ile Gly Val Val Ala Val Lys Ala Ile Asn Ser Asn Tyr
 85 90 95

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<210> 55
<211> 174
<212> PRT
<213> Homo sapiens
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<400> 55
Met Thr Cys Gln Ala Leu Gly Gln Asp Met Val Ser Pro Glu Ala Thr
  1             5             10             15
Asn Ser Ser Ser Ser Ser Phe Ser Ser Pro Ser Ser Ala Gly Arg His
      20             25             30
Val Arg Ser Tyr Asn His Leu Gln Gly Asp Val Arg Trp Arg Lys Leu
      35             40             45
Phe Ser Phe Thr Lys Tyr Phe Leu Lys Ile Glu Lys Asn Gly Lys Val
      50             55             60
Ser Gly Thr Lys Lys Glu Asn Cys Pro Tyr Ser Ile Leu Glu Ile Thr
      65             70             75             80
Ser Val Glu Ile Gly Val Val Ala Val Lys Ala Ile Asn Ser Asn Tyr
      85             90             95
Tyr Leu Ala Met Asn Lys Lys Gly Lys Leu Tyr Gly Ser Lys Glu Phe
      100            105            110
Asn Asn Asp Cys Lys Leu Lys Glu Arg Ile Glu Glu Asn Gly Tyr Asn
      115            120            125

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Thr Tyr Ala Ser Phe Asn Trp Gln His Asn Gly Arg Gln Met Tyr Val
 130 135 140

Ala Leu Asn Gly Lys Gly Ala Pro Arg Arg Gly Gln Lys Thr Arg Arg
 145 150 155 160

Lys Asn Thr Ser Ala His Phe Leu Pro Met Val Val His Ser
 165 170

<210> 56
 <211> 35
 <212> DNA
 <213> Homo sapiens

<400> 56
 ggacctcat gacctgccag gctctgggtc aggac 35

<210> 57
 <211> 28
 <212> DNA
 <213> Homo sapiens

<400> 57
 ggacagccat ggctggctcg cacgttcg 28

<210> 58
 <211> 29
 <212> DNA
 <213> Homo sapiens

<400> 58
 ggacagccat ggttcggttg cgtaaactg 29

<210> 59
 <211> 31
 <212> DNA
 <213> Homo sapiens

<400> 59
 ggacagccat ggaaaaaac ggtaaagttt c 31

<210> 60
 <211> 29
 <212> DNA
 <213> Homo sapiens

<400> 60

-32-

ggacccccat ggagaactgc ccgtagagc

29

<210> 61

<211> 32

<212> DNA

<213> Homo sapiens

<400> 61

ggacccccat ggtcaaagcc attaacagca ac

32

<210> 62

<211> 33

<212> DNA

<213> Homo sapiens

<400> 62

ggacccccat ggggaaactc tatggctcaa aag

33

<210> 63

<211> 37

<212> DNA

<213> Homo sapiens

<400> 63

ctgcccaagc ttattatgag tgtaccacca ttggaag

37

<210> 64

<211> 36

<212> DNA

<213> Homo sapiens

<400> 64

ctgcccaagc ttattacttc agcttacagt cattgt

36

<210> 65

<211> 525

<212> DNA

<213> Homo sapiens

<220>

<221> CDS

<222> (1)..(522)

<400> 65

atg acc tgc cag gct ctg ggt cag gac atg gtt tct ccg gaa gct acc 48
Met Thr Cys Gln Ala Leu Gly Gln Asp Met Val Ser Pro Glu Ala Thr

1

5

10

15

-33-

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aac tct tcc tct tcc tct ttc tct tcc ccg tct tcc gct ggt cgt cac   96
Asn Ser Ser Ser Ser Ser Phe Ser Ser Pro Ser Ser Ala Gly Arg His
      20              25              30

gtt cgt tct tac aac cac ctg cag ggt gac gtt cgt tgg cgt aaa ctg   144
Val Arg Ser Tyr Asn His Leu Gln Gly Asp Val Arg Trp Arg Lys Leu
      35              40              45

ttc tct ttc acc aaa tac ttc ctg aaa atc gaa aaa aac ggt aaa gtt   192
Phe Ser Phe Thr Lys Tyr Phe Leu Lys Ile Glu Lys Asn Gly Lys Val
      50              55              60

tct ggg acc aag aag gag aac tgc ccg tac agc atc ctg gag ata aca   240
Ser Gly Thr Lys Lys Glu Asn Cys Pro Tyr Ser Ile Leu Glu Ile Thr
      65              70              75              80

tca gta gaa atc gga gtt gtt gcc gtc aaa gcc att aac agc aac tat   288
Ser Val Glu Ile Gly Val Val Ala Val Lys Ala Ile Asn Ser Asn Tyr
      85              90              95

tac tta gcc atg aac aag aag ggg aaa ctc tat ggc tca aaa gaa ttt   336
Tyr Leu Ala Met Asn Lys Lys Gly Lys Leu Tyr Gly Ser Lys Glu Phe
      100              105              110

aac aat gac tgt aag ctg aag gag agg ata gag gaa aat gga tac aat   384
Asn Asn Asp Cys Lys Leu Lys Glu Arg Ile Glu Glu Asn Gly Tyr Asn
      115              120              125

acc tat gca tca ttt aac tgg cag cat aat ggg agg caa atg tat gtg   432
Thr Tyr Ala Ser Phe Asn Trp Gln His Asn Gly Arg Gln Met Tyr Val
      130              135              140

gca ttg aat gga aaa gga gct cca agg aga gga cag aaa aca cga agg   480
Ala Leu Asn Gly Lys Gly Ala Pro Arg Arg Gly Gln Lys Thr Arg Arg
      145              150              155              160

aaa aac acc tct gct cac ttt ctt cca atg gtg gta cac tca tag       525
Lys Asn Thr Ser Ala His Phe Leu Pro Met Val Val His Ser
      165              170

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<210> 66

<211> 174

<212> PRT

<213> Homo sapiens

<400> 66

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Met Thr Cys Gln Ala Leu Gly Gln Asp Met Val Ser Pro Glu Ala Thr
  1              5              10              15

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```

Asn Ser Ser Ser Ser Ser Phe Ser Ser Pro Ser Ser Ala Gly Arg His

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	20		25		30
Val Arg Ser Tyr Asn His Leu Gln Gly Asp Val Arg Trp Arg Lys Leu					
	35		40		45
Phe Ser Phe Thr Lys Tyr Phe Leu Lys Ile Glu Lys Asn Gly Lys Val					
	50		55		60
Ser Gly Thr Lys Lys Glu Asn Cys Pro Tyr Ser Ile Leu Glu Ile Thr					
	65		70		80
Ser Val Glu Ile Gly Val Val Ala Val Lys Ala Ile Asn Ser Asn Tyr					
		85		90	95
Tyr Leu Ala Met Asn Lys Lys Gly Lys Leu Tyr Gly Ser Lys Glu Phe					
	100		105		110
Asn Asn Asp Cys Lys Leu Lys Glu Arg Ile Glu Glu Asn Gly Tyr Asn					
	115		120		125
Thr Tyr Ala Ser Phe Asn Trp Gln His Asn Gly Arg Gln Met Tyr Val					
	130		135		140
Ala Leu Asn Gly Lys Gly Ala Pro Arg Arg Gly Gln Lys Thr Arg Arg					
	145		150		155
					160
Lys Asn Thr Ser Ala His Phe Leu Pro Met Val Val His Ser					
	165		170		

<210> 67

<211> 444

<212> DNA

<213> Homo sapiens

<220>

<221> CDS

<222> (1)..(441)

<400> 67

atg gct ggt cgt cac gtt cgt tct tac aac cac ctg cag ggt gac gtt	48
Met Ala Gly Arg His Val Arg Ser Tyr Asn His Leu Gln Gly Asp Val	
1 5 10 15	

cgt tgg cgt aaa ctg ttc tct ttc acc aaa tac ttc ctg aaa atc gaa	96
Arg Trp Arg Lys Leu Phe Ser Phe Thr Lys Tyr Phe Leu Lys Ile Glu	
20 25 30	

aaa aac ggt aaa gtt tct ggg acc aag aag gag aac tgc ccg tac agc	144
Lys Asn Gly Lys Val Ser Gly Thr Lys Lys Glu Asn Cys Pro Tyr Ser	
35 40 45	

atc ctg gag ata aca tca gta gaa atc gga gtt gtt gcc gtc aaa gcc 192
Ile Leu Glu Ile Thr Ser Val Glu Ile Gly Val Val Ala Val Lys Ala
50 55 60

att aac agc aac tat tac tta gcc atg aac aag aag ggg aaa ctc tat 240
Ile Asn Ser Asn Tyr Tyr Leu Ala Met Asn Lys Lys Gly Lys Leu Tyr
65 70 75 80

ggc tca aaa gaa ttt aac aat gac tgt aag ctg aag gag agg ata gag 288
Gly Ser Lys Glu Phe Asn Asn Asp Cys Lys Leu Lys Glu Arg Ile Glu
85 90 95

gaa aat gga tac aat acc tat gca tca ttt aac tgg cag cat aat ggg 336
Glu Asn Gly Tyr Asn Thr Tyr Ala Ser Phe Asn Trp Gln His Asn Gly
100 105 110

agg caa atg tat gtg gca ttg aat gga aaa gga gct cca agg aga gga 384
Arg Gln Met Tyr Val Ala Leu Asn Gly Lys Gly Ala Pro Arg Arg Gly
115 120 125

cag aaa aca cga agg aaa aac acc tct gct cac ttt ctt cca atg gtg 432
Gln Lys Thr Arg Arg Lys Asn Thr Ser Ala His Phe Leu Pro Met Val
130 135 140

gta cac tca tag 444
Val His Ser
145

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<210> 68
<211> 147
<212> PRT
<213> Homo sapiens
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<400> 68
Met Ala Gly Arg His Val Arg Ser Tyr Asn His Leu Gln Gly Asp Val
1 5 10 15

Arg Trp Arg Lys Leu Phe Ser Phe Thr Lys Tyr Phe Leu Lys Ile Glu
20 25 30

Lys Asn Gly Lys Val Ser Gly Thr Lys Lys Glu Asn Cys Pro Tyr Ser
35 40 45

Ile Leu Glu Ile Thr Ser Val Glu Ile Gly Val Val Ala Val Lys Ala
50 55 60

Ile Asn Ser Asn Tyr Tyr Leu Ala Met Asn Lys Lys Gly Lys Leu Tyr
65 70 75 80

Gly Ser Lys Glu Phe Asn Asn Asp Cys Lys Leu Lys Glu Arg Ile Glu
85 90 95

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Glu Asn Gly Tyr Asn Thr Tyr Ala Ser Phe Asn Trp Gln His Asn Gly
 100 105 110

Arg Gln Met Tyr Val Ala Leu Asn Gly Lys Gly Ala Pro Arg Arg Gly
 115 120 125

Gln Lys Thr Arg Arg Lys Asn Thr Ser Ala His Phe Leu Pro Met Val
 130 135 140

Val His Ser
 145

<210> 69

<211> 402

<212> DNA

<213> Homo sapiens

<220>

<221> CDS

<222> (1)..(399)

<400> 69

atg gtt cgt tgg cgt aaa ctg ttc tct ttc acc aaa tac ttc ctg aaa 48
 Met Val Arg Trp Arg Lys Leu Phe Ser Phe Thr Lys Tyr Phe Leu Lys
 1 5 10 15

atc gaa aaa aac ggt aaa gtt tct ggg acc aag aag gag aac tgc ccg 96
 Ile Glu Lys Asn Gly Lys Val Ser Gly Thr Lys Lys Glu Asn Cys Pro
 20 25 30

tac agc atc ctg gag ata aca tca gta gaa atc gga gtt gtt gcc gtc 144
 Tyr Ser Ile Leu Glu Ile Thr Ser Val Glu Ile Gly Val Val Ala Val
 35 40 45

aaa gcc att aac agc aac tat tac tta gcc atg aac aag aag ggg aaa 192
 Lys Ala Ile Asn Ser Asn Tyr Tyr Leu Ala Met Asn Lys Lys Gly Lys
 50 55 60

ctc tat ggc tca aaa gaa ttt aac aat gac tgt aag ctg aag gag agg 240
 Leu Tyr Gly Ser Lys Glu Phe Asn Asn Asp Cys Lys Leu Lys Glu Arg
 65 70 75 80

ata gag gaa aat gga tac aat acc tat gca tca ttt aac tgg cag cat 288
 Ile Glu Glu Asn Gly Tyr Asn Thr Tyr Ala Ser Phe Asn Trp Gln His
 85 90 95

aat ggg agg caa atg tat gtg gca ttg aat gga aaa gga gct cca agg 336
 Asn Gly Arg Gln Met Tyr Val Ala Leu Asn Gly Lys Gly Ala Pro Arg
 100 105 110

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aga gga cag aaa aca cga agg aaa aac acc tct gct cac ttt ctt cca 384
 Arg Gly Gln Lys Thr Arg Arg Lys Asn Thr Ser Ala His Phe Leu Pro
 115 120 125

atg gtg gta cac tca tag 402
 Met Val Val His Ser
 130

<210> 70
 <211> 133
 <212> PRT
 <213> Homo sapiens

<400> 70
 Met Val Arg Trp Arg Lys Leu Phe Ser Phe Thr Lys Tyr Phe Leu Lys
 1 5 10 15

Ile Glu Lys Asn Gly Lys Val Ser Gly Thr Lys Lys Glu Asn Cys Pro
 20 25 30

Tyr Ser Ile Leu Glu Ile Thr Ser Val Glu Ile Gly Val Val Ala Val
 35 40 45

Lys Ala Ile Asn Ser Asn Tyr Tyr Leu Ala Met Asn Lys Lys Gly Lys
 50 55 60

Leu Tyr Gly Ser Lys Glu Phe Asn Asn Asp Cys Lys Leu Lys Glu Arg
 65 70 75 80

Ile Glu Glu Asn Gly Tyr Asn Thr Tyr Ala Ser Phe Asn Trp Gln His
 85 90 95

Asn Gly Arg Gln Met Tyr Val Ala Leu Asn Gly Lys Gly Ala Pro Arg
 100 105 110

Arg Gly Gln Lys Thr Arg Arg Lys Asn Thr Ser Ala His Phe Leu Pro
 115 120 125

Met Val Val His Ser
 130

<210> 71
 <211> 354
 <212> DNA
 <213> Homo sapiens

<220>
 <221> CDS
 <222> (1)..(351)

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<400> 71

atg gaa aaa aac ggt aaa gtt tct ggg acc aag aag gag aac tgc ccg 48
 Met Glu Lys Asn Gly Lys Val Ser Gly Thr Lys Lys Glu Asn Cys Pro
 1 5 10 15

tac agc atc ctg gag ata aca tca gta gaa atc gga gtt gtt gcc gtc 96
 Tyr Ser Ile Leu Glu Ile Thr Ser Val Glu Ile Gly Val Val Ala Val
 20 25 30

aaa gcc att aac agc aac tat tac tta gcc atg aac aag aag ggg aaa 144
 Lys Ala Ile Asn Ser Asn Tyr Tyr Leu Ala Met Asn Lys Lys Gly Lys
 35 40 45

ctc tat ggc tca aaa gaa ttt aac aat gac tgt aag ctg aag gag agg 192
 Leu Tyr Gly Ser Lys Glu Phe Asn Asn Asp Cys Lys Leu Lys Glu Arg
 50 55 60

ata gag gaa aat gga tac aat acc tat gca tca ttt aac tgg cag cat 240
 Ile Glu Glu Asn Gly Tyr Asn Thr Tyr Ala Ser Phe Asn Trp Gln His
 65 70 75 80

aat ggg agg caa atg tat gtg gca ttg aat gga aaa gga gct cca agg 288
 Asn Gly Arg Gln Met Tyr Val Ala Leu Asn Gly Lys Gly Ala Pro Arg
 85 90 95

aga gga cag aaa aca cga agg aaa aac acc tct gct cac ttt ctt cca 336
 Arg Gly Gln Lys Thr Arg Arg Lys Asn Thr Ser Ala His Phe Leu Pro
 100 105 110

atg gtg gta cac tca tag 354
 Met Val Val His Ser
 115

<210> 72

<211> 117

<212> PRT

<213> Homo sapiens

<400> 72

Met Glu Lys Asn Gly Lys Val Ser Gly Thr Lys Lys Glu Asn Cys Pro
 1 5 10 15

Tyr Ser Ile Leu Glu Ile Thr Ser Val Glu Ile Gly Val Val Ala Val
 20 25 30

Lys Ala Ile Asn Ser Asn Tyr Tyr Leu Ala Met Asn Lys Lys Gly Lys
 35 40 45

Leu Tyr Gly Ser Lys Glu Phe Asn Asn Asp Cys Lys Leu Lys Glu Arg
 50 55 60

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Ile Glu Glu Asn Gly Tyr Asn Thr Tyr Ala Ser Phe Asn Trp Gln His
65 70 75 80

Asn Gly Arg Gln Met Tyr Val Ala Leu Asn Gly Lys Gly Ala Pro Arg
85 90 95

Arg Gly Gln Lys Thr Arg Arg Lys Asn Thr Ser Ala His Phe Leu Pro
100 105 110

Met Val Val His Ser
115

<210> 73

<211> 321

<212> DNA

<213> Homo sapiens

<220>

<221> CDS

<222> (1)..(318)

<400> 73

atg gag aac tgc ccg tac agc atc ctg gag ata aca tca gta gaa atc 48
Met Glu Asn Cys Pro Tyr Ser Ile Leu Glu Ile Thr Ser Val Glu Ile
1 5 10 15

gga gtt gtt gcc gtc aaa gcc att aac agc aac tat tac tta gcc atg 96
Gly Val Val Ala Val Lys Ala Ile Asn Ser Asn Tyr Tyr Leu Ala Met
20 25 30

aac aag aag ggg aaa ctc tat ggc tca aaa gaa ttt aac aat gac tgt 144
Asn Lys Lys Gly Lys Leu Tyr Gly Ser Lys Glu Phe Asn Asn Asp Cys
35 40 45

aag ctg aag gag agg ata gag gaa aat gga tac aat acc tat gca tca 192
Lys Leu Lys Glu Arg Ile Glu Glu Asn Gly Tyr Asn Thr Tyr Ala Ser
50 55 60

ttt aac tgg cag cat aat ggg agg caa atg tat gtg gca ttg aat gga 240
Phe Asn Trp Gln His Asn Gly Arg Gln Met Tyr Val Ala Leu Asn Gly
65 70 75 80

aaa gga gct cca agg aga gga cag aaa aca cga agg aaa aac acc tct 288
Lys Gly Ala Pro Arg Arg Gly Gln Lys Thr Arg Arg Lys Asn Thr Ser
85 90 95

gct cac ttt ctt cca atg gtg gta cac tca tag 321
Ala His Phe Leu Pro Met Val Val His Ser
100 105

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<210> 74
 <211> 106
 <212> PRT
 <213> Homo sapiens

<400> 74
 Met Glu Asn Cys Pro Tyr Ser Ile Leu Glu Ile Thr Ser Val Glu Ile
 1 5 10 15
 Gly Val Val Ala Val Lys Ala Ile Asn Ser Asn Tyr Tyr Leu Ala Met
 20 25 30
 Asn Lys Lys Gly Lys Leu Tyr Gly Ser Lys Glu Phe Asn Asn Asp Cys
 35 40 45
 Lys Leu Lys Glu Arg Ile Glu Glu Asn Gly Tyr Asn Thr Tyr Ala Ser
 50 55 60
 Phe Asn Trp Gln His Asn Gly Arg Gln Met Tyr Val Ala Leu Asn Gly
 65 70 75 80
 Lys Gly Ala Pro Arg Arg Gly Gln Lys Thr Arg Arg Lys Asn Thr Ser
 85 90 95
 Ala His Phe Leu Pro Met Val Val His Ser
 100 105

<210> 75
 <211> 264
 <212> DNA
 <213> Homo sapiens

<220>
 <221> CDS
 <222> (1)..(261)

<400> 75
 atg gtc aaa gcc att aac agc aac tat tac tta gcc atg aac aag aag 48
 Met Val Lys Ala Ile Asn Ser Asn Tyr Tyr Leu Ala Met Asn Lys Lys
 1 5 10 15
 ggg aaa ctc tat ggc tca aaa gaa ttt aac aat gac tgt aag ctg aag 96
 Gly Lys Leu Tyr Gly Ser Lys Glu Phe Asn Asn Asp Cys Lys Leu Lys
 20 25 30
 gag agg ata gag gaa aat gga tac aat acc tat gca tca ttt aac tgg 144
 Glu Arg Ile Glu Glu Asn Gly Tyr Asn Thr Tyr Ala Ser Phe Asn Trp
 35 40 45
 cag cat aat ggg agg caa atg tat gtg gca ttg aat gga aaa gga gct 192
 Gln His Asn Gly Arg Gln Met Tyr Val Ala Leu Asn Gly Lys Gly Ala

50

55

60

65 70 75 80

85

<211> 87

<212> PRT

<213> Homo sapiens

<400> 76

Met Val Lys Ala Ile Asn Ser Asn Tyr Tyr Leu Ala Met Asn Lys Lys

1 5 10 15

Gly Lys Leu Tyr Gly Ser Lys Glu Phe Asn Asn Asp Cys Lys Leu Lys
20 25 30

Glu Arg Ile Glu Glu Asn Gly Tyr Asn Thr Tyr Ala Ser Phe Asn Trp
35 40 45

Gln His Asn Gly Arg Gln Met Tyr Val Ala Leu Asn Gly Lys Gly Ala
50 55 60

Pro Arg Arg Gly Gln Lys Thr Arg Arg Lys Asn Thr Ser Ala His Phe
65 70 75 80

Leu Pro Met Val Val His Ser
85

<210> 77

<211> 219

<212> DNA

<213> Homo sapiens

<220>

<221> CDS

$\langle 222 \rangle \quad (1) \dots (216)$

<400> 77

atg ggg aaa ctc tat ggc tca aaa gaa ttt aac aat gac tgt aag ctg 48

Met Gly Lys Leu Tyr Gly Ser Lys Glu Phe Asn Asn Asp Cys Lys Leu
1 5 10 15

aag gag agg ata gag gaa aat gga tac aat acc tat gca tca ttt aac 96
Lys Glu Arg Ile Glu Glu Asn Gly Tyr Asn Thr Tyr Ala Ser Phe Asn

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20	25	30	
tgg cag cat aat ggg agg caa atg tat gtg gca ttg aat gga aaa gga			144
Trp Gln His Asn Gly Arg Gln Met Tyr Val Ala Leu Asn Gly Lys Gly			
35	40	45	
gct cca agg aga gga cag aaa aca cga agg aaa aac acc tct gct cac			192
Ala Pro Arg Arg Gly Gln Lys Thr Arg Arg Lys Asn Thr Ser Ala His			
50	55	60	
ttt ctt cca atg gtg gta cac tca tag			219
Phe Leu Pro Met Val Val His Ser			
65	70		

<210> 78
 <211> 72
 <212> PRT
 <213> Homo sapiens

<400> 78
 Met Gly Lys Leu Tyr Gly Ser Lys Glu Phe Asn Asn Asp Cys Lys Leu
 1 5 10 15
 Lys Glu Arg Ile Glu Glu Asn Gly Tyr Asn Thr Tyr Ala Ser Phe Asn
 20 25 30
 Trp Gln His Asn Gly Arg Gln Met Tyr Val Ala Leu Asn Gly Lys Gly
 35 40 45
 Ala Pro Arg Arg Gly Gln Lys Thr Arg Arg Lys Asn Thr Ser Ala His
 50 55 60
 Phe Leu Pro Met Val Val His Ser
 65 70

<210> 79
 <211> 357
 <212> DNA
 <213> Homo sapiens

<220>
 <221> CDS
 <222> (1)..(357)

<400> 79
 atg acc tgc cag gct ctg ggt cag gac atg gtt tct ccg gaa gct acc 48
 Met Thr Cys Gln Ala Leu Gly Gln Asp Met Val Ser Pro Glu Ala Thr
 1 5 10 15
 aac tct tcc tct tcc tct ttc tct tcc ccg tct tcc gct ggt cgt cac 96

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Asn Ser Ser Ser Ser Ser Phe Ser Ser Pro Ser Ser Ala Gly Arg His
 20 25 30

 gtt cgt tct tac aac cac ctg cag ggt gac gtt cgt tgg cgt aaa ctg 144
 Val Arg Ser Tyr Asn His Leu Gln Gly Asp Val Arg Trp Arg Lys Leu
 35 40 45

 ttc tct ttc acc aaa tac ttc ctg aaa atc gaa aaa aac ggt aaa gtt 192
 Phe Ser Phe Thr Lys Tyr Phe Leu Lys Ile Glu Lys Asn Gly Lys Val
 50 55 60

 tct ggg acc aag aag gag aac tgc ccg tac agc atc ctg gag ata aca 240
 Ser Gly Thr Lys Lys Glu Asn Cys Pro Tyr Ser Ile Leu Glu Ile Thr
 65 70 75 80

 tca gta gaa atc gga gtt gtt gcc gtc aaa gcc att aac agc aac tat 288
 Ser Val Glu Ile Gly Val Val Ala Val Lys Ala Ile Asn Ser Asn Tyr
 85 90 95

 tac tta gcc atg aac aag aag ggg aaa ctc tat ggc tca aaa gaa ttt 336
 Tyr Leu Ala Met Asn Lys Lys Gly Lys Leu Tyr Gly Ser Lys Glu Phe
 100 105 110

 aac aat gac tgt aag ctg aag 357
 Asn Asn Asp Cys Lys Leu Lys
 115

<210> 80

<211> 119

<212> PRT

<213> Homo sapiens

<400> 80

Met Thr Cys Gln Ala Leu Gly Gln Asp Met Val Ser Pro Glu Ala Thr
 1 5 10 15

 Asn Ser Ser Ser Ser Ser Phe Ser Ser Pro Ser Ser Ala Gly Arg His
 20 25 30

 Val Arg Ser Tyr Asn His Leu Gln Gly Asp Val Arg Trp Arg Lys Leu
 35 40 45

 Phe Ser Phe Thr Lys Tyr Phe Leu Lys Ile Glu Lys Asn Gly Lys Val
 50 55 60

 Ser Gly Thr Lys Lys Glu Asn Cys Pro Tyr Ser Ile Leu Glu Ile Thr
 65 70 75 80

 Ser Val Glu Ile Gly Val Val Ala Val Lys Ala Ile Asn Ser Asn Tyr
 85 90 95

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Tyr Leu Ala Met Asn Lys Lys Gly Lys Leu Tyr Gly Ser Lys Glu Phe
 100 105 110

Asn Asn Asp Cys Lys Leu Lys
 115

<210> 81

<211> 276

<212> DNA

<213> Homo sapiens

<220>

<221> CDS

<222> (1)..(276)

<400> 81

atg gct ggt cgt cac gtt cgt tct tac aac cac ctg cag ggt gac gtt 48
 Met Ala Gly Arg His Val Arg Ser Tyr Asn His Leu Gln Gly Asp Val
 1 5 10 15

cgt tgg cgt aaa ctg ttc tct ttc acc aaa tac ttc ctg aaa atc gaa 96
 Arg Trp Arg Lys Leu Phe Ser Phe Thr Lys Tyr Phe Leu Lys Ile Glu
 20 25 30

aaa aac ggt aaa gtt tct ggg acc aag aag gag aac tgc ccg tac agc 144
 Lys Asn Gly Lys Val Ser Gly Thr Lys Lys Glu Asn Cys Pro Tyr Ser
 35 40 45

atc ctg gag ata aca tca gta gaa atc gga gtt gtt gcc gtc aaa gcc 192
 Ile Leu Glu Ile Thr Ser Val Glu Ile Gly Val Val Ala Val Lys Ala
 50 55 60

att aac agc aac tat tac tta gcc atg aac aag aag ggg aaa ctc tat 240
 Ile Asn Ser Asn Tyr Tyr Leu Ala Met Asn Lys Lys Gly Lys Leu Tyr
 65 70 75 80

ggc tca aaa gaa ttt aac aat gac tgt aag ctg aag 276
 Gly Ser Lys Glu Phe Asn Asn Asp Cys Lys Leu Lys
 85 90

<210> 82

<211> 92

<212> PRT

<213> Homo sapiens

<400> 82

Met Ala Gly Arg His Val Arg Ser Tyr Asn His Leu Gln Gly Asp Val
 1 5 10 15

Arg Trp Arg Lys Leu Phe Ser Phe Thr Lys Tyr Phe Leu Lys Ile Glu

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	20		25		30
Lys Asn Gly Lys Val Ser Gly Thr Lys Lys Glu Asn Cys Pro Tyr Ser					
	35		40		45
Ile Leu Glu Ile Thr Ser Val Glu Ile Gly Val Val Ala Val Lys Ala					
	50		55		60
Ile Asn Ser Asn Tyr Tyr Leu Ala Met Asn Lys Lys Gly Lys Leu Tyr					
	65		70		75 80
Gly Ser Lys Glu Phe Asn Asn Asp Cys Lys Leu Lys					
	85		90		

<210> 83
 <211> 525
 <212> DNA
 <213> Homo sapiens

<400> 83
 atgacctctc aggctctggg tcaggacatg gtttctccgg aagctaccaa ctcttctct 60
 tctcttttct ctccccgctc ttccgctggg cgtaacgttc gttcttataa ccacctgcag 120
 ggtgacgttc gttggcgtaa actgttctct ttcaccaaact acttcttgaa aatcgaaaaa 180
 aacggtaaag tttctgggac caagaaggag aactctccgt acagcatcct ggagataaca 240
 tcagtagaaa tcggagttgt tgccgtcaaa gccattaaca gcaactatta cttagccatg 300
 aacaagaagg ggaaactcta tggctcaaaa gaatttaaca atgactgtaa gctgaaggag 360
 aggatagagg aaaatggata caatacctat gcatacttta actggcagca taatgggagg 420
 caaatgtatg tggcattgaa tggaaaagga gctccaagga gaggacagaa aacacgaagg 480
 aaaaacacct ctgctcactt tcttccaatg gtggtacact catag 525

<210> 84
 <211> 525
 <212> DNA
 <213> Homo sapiens

<400> 84
 atgacctgcc aggctctggg tcaggacatg gtttctccgg aagctaccaa ctcttctct 60
 tctcttttct ctccccgctc ttccgctggg cgtaacgttc gttcttataa ccacctgcag 120
 ggtgacgttc gttggcgtaa actgttctct ttcaccaaact acttcttgaa aatcgaaaaa 180

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aacggtaaag tttctgggac caagaaggag aactctccgt acagcatcct ggagataaca 240
tcagtagaaa tcggagttgt tgccgtcaaa gccattaaca gcaactatta ctagccatg 300
aacaagaagg ggaaactcta tggctcaaaa gaatttaaca atgactgtaa gctgaaggag 360
aggatagagg aaaatggata caatacctat gcatcattta actggcagca taatgggagg 420
caaatgtatg tggcattgaa tggaaaagga gctccaagga gaggacagaa aacacgaagg 480
aaaaacacct ctgctcactt tcttccaatg gtggtacact catag 525

<210> 85
<211> 29
<212> DNA
<213> Homo sapiens

<400> 85
ggaccctcat gacctctcag gctctgggt 29

<210> 86
<211> 21
<212> DNA
<213> Homo sapiens

<400> 86
aaggagaact ctccgtacag c 21

<210> 87
<211> 21
<212> DNA
<213> Homo sapiens

<400> 87
gctgtacggt ctgttctcct t 21

<210> 88
<211> 35
<212> DNA
<213> Homo sapiens

<400> 88
ggaccctcat gacctgccag gctctgggtc aggac 35

<210> 89
<211> 37
<212> DNA

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<213> Homo sapiens

<400> 89

ctgccaagc ttattatgag tgtaccacca ttggaag

37

<210> 90

<211> 33

<212> DNA

<213> Homo sapiens

<400> 90

aaaggatcct gccaggctct gggtcaggac atg

33

<210> 91

<211> 32

<212> DNA

<213> Homo sapiens

<400> 91

gcggcacatg tcttacaacc acctgcaggg tg

32

<210> 92

<211> 28

<212> DNA

<213> Homo sapiens

<400> 92

gggccaagc ttatgagtgt accaccat

28

<210> 93

<211> 36

<212> DNA

<213> Homo sapiens

<400> 93

ccggcggatc ccatatgtct tacaaccacc tgcagg

36

<210> 94

<211> 35

<212> DNA

<213> Homo sapiens

<400> 94

ccggcggatc cttattatga gtgtaccacc attgg

35

<210> 95

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<211> 426

<212> DNA

<213> Homo sapiens

<400> 95

atgtcttaca accacctgca gggtagcgtt cggtggcgta aactgttctc tttcaccaaa 60
 tacttcctga aaatcgaaaa aaacggtaaa gtttctggga ccaagaagga gaactgcccg 120
 tacagcatcc tggagataac atcagtagaa atcggagttg ttgccgtcaa agccattaac 180
 agcaactatt acttagccat gaacaagaag gggaaactct atgggtcaaa agaatttaac 240
 aatgactgta agctgaagga gaggatagag gaaaatggat acaataccta tgcattcattt 300
 aactggcagc ataatgggag gcaaattgtat gtggcattga atggaaaagg agctccaagg 360
 agaggacaga aaacacgaag gaaaaacacc tctgtcact ttcttccaat ggtggtacac 420
 tcataa 426

<210> 96

<211> 141

<212> PRT

<213> Homo sapiens

<400> 96

Met Ser Tyr Asn His Leu Gln Gly Asp Val Arg Trp Arg Lys Leu Phe
 1 5 10 15
 Ser Phe Thr Lys Tyr Phe Leu Lys Ile Glu Lys Asn Gly Lys Val Ser
 20 25 30
 Gly Thr Lys Lys Glu Asn Cys Pro Tyr Ser Ile Leu Glu Ile Thr Ser
 35 40 45
 Val Glu Ile Gly Val Val Ala Val Lys Ala Ile Asn Ser Asn Tyr Tyr
 50 55 60
 Leu Ala Met Asn Lys Lys Gly Lys Leu Tyr Gly Ser Lys Glu Phe Asn
 65 70 75 80
 Asn Asp Cys Lys Leu Lys Glu Arg Ile Glu Glu Asn Gly Tyr Asn Thr
 85 90 95
 Tyr Ala Ser Phe Asn Trp Gln His Asn Gly Arg Gln Met Tyr Val Ala
 100 105 110
 Leu Asn Gly Lys Gly Ala Pro Arg Arg Gly Gln Lys Thr Arg Arg Lys
 115 120 125

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Asn Thr Ser Ala His Phe Leu Pro Met Val Val His Ser
 130 135 140

<210> 97
 <211> 20
 <212> DNA
 <213> Homo sapiens

<400> 97
 caaccacctg caggggtgacg 20

<210> 98
 <211> 78
 <212> DNA
 <213> Homo sapiens

<400> 98
 aacggctcgac aaatgtatgt ggcactgaac ggtaaagggtg ctccacgtcg tggtcagaaa 60
 acccgctcgta aaaacacc 78

<210> 99
 <211> 76
 <212> DNA
 <213> Homo sapiens

<400> 99
 gggcccaagc ttaagagtgt accaccattg gcagaaagtg agcagaggtg tttttacgac 60
 gggttttctg accacg 76

<210> 100
 <211> 23
 <212> DNA
 <213> Homo sapiens

<400> 100
 gccacataca tttgtcgacc gtt 23

<210> 101
 <211> 19
 <212> DNA
 <213> Homo sapiens

<400> 101
 gggcccaagc ttaagagtg 19

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<210> 102
<211> 23
<212> DNA
<213> Homo sapiens

<400> 102
gccacataca tttgtcgacc gtt 23

<210> 103
<211> 90
<212> DNA
<213> Homo sapiens

<400> 103
ctgcagggtg acgttcgttg gcgtaaactg ttctccttca ccaaatactt cctgaaaatc 60
gaaaaaaacg gttaaagtttc tggtagcaag 90

<210> 104
<211> 90
<212> DNA
<213> Homo sapiens

<400> 104
agctttaaca gcaacaacac cgatttcaac ggaggtgatt tccaggatgg agtacgggca 60
gttttctttc ttggtaccag aaactttacc 90

<210> 105
<211> 90
<212> DNA
<213> Homo sapiens

<400> 105
ggtgttggtg ctgttaaagc tatcaactcc aactactacc tggctatgaa caagaaaggt 60
aaactgtacg gttccaaaga atttaacaac 90

<210> 106
<211> 100
<212> DNA
<213> Homo sapiens

<400> 106
gtcgaccgtt gtgctgccag ttgaaggaag cgtaggtgtt gtaaccgttt tcttcgatac 60
gttctttcag tttacagtcg ttgttaaatt ctttgggaacc 100

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<210> 107
<211> 25
<212> DNA
<213> Homo sapiens

<400> 107
gcggcgctcga ccgttggtgct gccag 25

<210> 108
<211> 26
<212> DNA
<213> Homo sapiens

<400> 108
gcggcctgca gggtgacgtt cgttgg 26

<210> 109
<211> 36
<212> DNA
<213> Homo sapiens

<400> 109
ccggcggatc ccatatgtct tacaaccacc tgcagg 36

<210> 110
<211> 34
<212> DNA
<213> Homo sapiens

<400> 110
cgcgcatat cttattaaga gtgtaccacc attg 34

<210> 111
<211> 426
<212> DNA
<213> Homo sapiens

<400> 111
atgtcttaca accacctgca gggtgacgtt cgttggcgta aactgttctc cttcaccaaa 60
tacttcctga aaatcgaaaa aaacggtaaa gtttctggta ccaagaaaga aaactgcccg 120
tactccatcc tggaatcac ctccgttgaa atcgggtgtg ttgctgttaa agctatcaac 180
tccaactact acctggctat gaacaagaaa ggtaaactgt acggttccaa agaatttaac 240

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aacgactgta aactgaaaga acgtatcgaa gaaaacggtt acaacaccta cgcttccttc 300
 aactggcagc acaacggtcg acaaattgtat gtggcactga acggtaaagg tgctccacgt 360
 cgtggtcaga aaaccgctcg taaaaacacc tctgctcact ttctgccaat ggtgggtacac 420
 tcttaa 426

<210> 112
 <211> 141
 <212> PRT
 <213> Homo sapiens

<400> 112
 Met Ser Tyr Asn His Leu Gln Gly Asp Val Arg Trp Arg Lys Leu Phe
 1 5 10 15
 Ser Phe Thr Lys Tyr Phe Leu Lys Ile Glu Lys Asn Gly Lys Val Ser
 20 25 30
 Gly Thr Lys Lys Glu Asn Cys Pro Tyr Ser Ile Leu Glu Ile Thr Ser
 35 40 45
 Val Glu Ile Gly Val Val Ala Val Lys Ala Ile Asn Ser Asn Tyr Tyr
 50 55 60
 Leu Ala Met Asn Lys Lys Gly Lys Leu Tyr Gly Ser Lys Glu Phe Asn
 65 70 75 80
 Asn Asp Cys Lys Leu Lys Glu Arg Ile Glu Glu Asn Gly Tyr Asn Thr
 85 90 95
 Tyr Ala Ser Phe Asn Trp Gln His Asn Gly Arg Gln Met Tyr Val Ala
 100 105 110
 Leu Asn Gly Lys Gly Ala Pro Arg Arg Gly Gln Lys Thr Arg Arg Lys
 115 120 125
 Asn Thr Ser Ala His Phe Leu Pro Met Val Val His Ser
 130 135 140

<210> 113
 <211> 28
 <212> DNA
 <213> Homo sapiens

<400> 113
 cgcggccatg gctctgggtc aggacatg

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<210> 114
 <211> 28
 <212> DNA
 <213> Homo sapiens

<400> 114
 gggcccaagc ttatgagtgt accaccat

28

<210> 115
 <211> 516
 <212> DNA
 <213> Homo sapiens

<400> 115
 atggctctgg gtcaagatat ggtttctccg gaagctacca actcttcctc ttcctctttc 60
 ttttccccgt ctccgctgg tcgtcacgtt cgttcttaca accacctgca gggtgacgtt 120
 cgttggcgta aactgttctc tttcaccaaa tacttctga aaatcgaaaa aaacggtaaa 180
 gtttctggga ccaagaagga gaactgcccg tacagcatcc tggagataac atcagtagaa 240
 atcggagttg ttgccgtcaa agccattaac agcaactatt acttagccat gaacaagaag 300
 gggaaactct atggctcaaa agaatttaac aatgactgta agctgaagga gaggatagag 360
 gaaaatggat acaataccta tgcattttt aactggcagc ataatgggag gcaaatgtat 420
 gtggcattga atggaaaagg agctccaagg agaggacaga aaacacgaag gaaaaacacc 480
 tctgctcact ttcttccaat ggtggtacac tcataa 516

<210> 116
 <211> 171
 <212> PRT
 <213> Homo sapiens

<400> 116
 Met Ala Leu Gly Gln Asp Met Val Ser Pro Glu Ala Thr Asn Ser Ser
 1 5 10 15
 Ser Ser Ser Phe Ser Ser Pro Ser Ser Ala Gly Arg His Val Arg Ser
 20 25 30
 Tyr Asn His Leu Gln Gly Asp Val Arg Trp Arg Lys Leu Phe Ser Phe
 35 40 45
 Thr Lys Tyr Phe Leu Lys Ile Glu Lys Asn Gly Lys Val Ser Gly Thr
 50 55 60

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Lys Lys Glu Asn Cys Pro Tyr Ser Ile Leu Glu Ile Thr Ser Val Glu
65 70 75 80

Ile Gly Val Val Ala Val Lys Ala Ile Asn Ser Asn Tyr Tyr Leu Ala
85 90 95

Met Asn Lys Lys Gly Lys Leu Tyr Gly Ser Lys Glu Phe Asn Asn Asp
100 105 110

Cys Lys Leu Lys Glu Arg Ile Glu Glu Asn Gly Tyr Asn Thr Tyr Ala
115 120 125

Ser Phe Asn Trp Gln His Asn Gly Arg Gln Met Tyr Val Ala Leu Asn
130 135 140

Gly Lys Gly Ala Pro Arg Arg Gly Gln Lys Thr Arg Arg Lys Asn Thr
145 150 155 160

Ser Ala His Phe Leu Pro Met Val Val His Ser
165 170

<210> 117

<211> 32

<212> DNA

<213> Homo sapiens

<400> 117

gcggcacatg tcttacaacc acctgcaggg tg

32

<210> 118

<211> 75

<212> DNA

<213> Homo sapiens

<400> 118

ctgccaagc ttttatgagt gtaccacat tggaagaaag tgagcagagg tgtttttttc 60

tcgtgttttc tgtcc

75

<210> 119

<211> 426

<212> DNA

<213> Homo sapiens

<400> 119

atgtcttaca accacctgca gggtagcggt cgttggcgta aactgttctc tttcaccaaa 60

tacttcctga aaatcgaaaa aaacggtaaa gtttctggga ccaagaagga gaactgcccg 120

-55-

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 <213> Homo sapiens

<400> 120
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 35 40 45
 Val Glu Ile Gly Val Val Ala Val Lys Ala Ile Asn Ser Asn Tyr Tyr
 50 55 60
 Leu Ala Met Asn Lys Lys Gly Lys Leu Tyr Gly Ser Lys Glu Phe Asn
 65 70 75 80
 Asn Asp Cys Lys Leu Lys Glu Arg Ile Glu Glu Asn Gly Tyr Asn Thr
 85 90 95
 Tyr Ala Ser Phe Asn Trp Gln His Asn Gly Arg Gln Met Tyr Val Ala
 100 105 110
 Leu Asn Gly Lys Gly Ala Pro Arg Arg Gly Gln Lys Thr Arg Glu Lys
 115 120 125
 Asn Thr Ser Ala His Phe Leu Pro Met Val Val His Ser
 130 135 140

<210> 121
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 <212> DNA
 <213> Homo sapiens

-56-

<400> 121

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32

<210> 122

<211> 75

<212> DNA

<213> Homo sapiens

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tcgtgttttc tgtcc

75

<210> 123

<211> 426

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aatgactgta agctgaagga gaggatagag gaaaatggat acaataccta tgcattttt 300

aactggcagc ataatgggag gcaaatgtat gtggcattga atggaaaagg agctccaagg 360

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<211> 141

<212> PRT

<213> Homo sapiens

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25

30

Gly Thr Lys Lys Glu Asn Cys Pro Tyr Ser Ile Leu Glu Ile Thr Ser

35

40

45

-57-

Val Glu Ile Gly Val Val Ala Val Lys Ala Ile Asn Ser Asn Tyr Tyr
50 55 60

Leu Ala Met Asn Lys Lys Gly Lys Leu Tyr Gly Ser Lys Glu Phe Asn
65 70 75 80

Asn Asp Cys Lys Leu Lys Glu Arg Ile Glu Glu Asn Gly Tyr Asn Thr
85 90 95

Tyr Ala Ser Phe Asn Trp Gln His Asn Gly Arg Gln Met Tyr Val Ala
100 105 110

Leu Asn Gly Lys Gly Ala Pro Arg Arg Gly Gln Lys Thr Arg Gln Lys
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130 135 140

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<211> 32

<212> DNA

<213> Homo sapiens

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32

<210> 126

<211> 84

<212> DNA

<213> Homo sapiens

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tcgtgtttcc tgtcctctcc ttgg

84

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<211> 426

<212> DNA

<213> Homo sapiens

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tacagcatcc tggagataac atcagtagaa atcggagttg ttgccgtcaa agccattaac 180

-58-

agcaactatt acttagccat gaacaagaag gggaaactct atggctcaaa agaatttaac 240
aatgactgta agctgaagga gaggatagag gaaaatggat acaataccta tgcattcattt 300
aactggcagc ataatgggag gcaaattgtat gtggcattga atggaaaagg agctccaagg 360
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<211> 141

<212> PRT

<213> Homo sapiens

<400> 128

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10

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Ser Phe Thr Lys Tyr Phe Leu Lys Ile Glu Lys Asn Gly Lys Val Ser

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25

30

Gly Thr Lys Lys Glu Asn Cys Pro Tyr Ser Ile Leu Glu Ile Thr Ser

35

40

45

Val Glu Ile Gly Val Val Ala Val Lys Ala Ile Asn Ser Asn Tyr Tyr

50

55

60

Leu Ala Met Asn Lys Lys Gly Lys Leu Tyr Gly Ser Lys Glu Phe Asn

65

70

75

80

Asn Asp Cys Lys Leu Lys Glu Arg Ile Glu Glu Asn Gly Tyr Asn Thr

85

90

95

Tyr Ala Ser Phe Asn Trp Gln His Asn Gly Arg Gln Met Tyr Val Ala

100

105

110

Leu Asn Gly Lys Gly Ala Pro Arg Arg Gly Gln Glu Thr Arg Arg Lys

115

120

125

Asn Thr Ser Ala His Phe Leu Pro Met Val Val His Ser

130

135

140

<210> 129

<211> 32

<212> DNA

<213> Homo sapiens

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32

-59-

<210> 130

<211> 84

<212> DNA

<213> Homo sapiens

<400> 130

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<211> 426

<212> DNA

<213> Homo sapiens

<400> 131

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tacagcatcc tggagataac atcagtagaa atcggagttg ttgccgtcaa agccattaac 180

agcaactatt acttagccat gaacaagaag gggaaactct atggctcaaa agaatttaac 240

aatgactgta agctgaagga gaggatagag gaaaatggat acaataccta tgcatcattt 300

aactggcagc ataatgggag gcaaatgtat gtggcattga atggaaaagg agctccaagg 360

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<212> PRT

<213> Homo sapiens

<400> 132

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Ser	Phe	Thr	Lys	Tyr	Phe	Leu	Lys	Ile	Glu	Lys	Asn	Gly	Lys	Val	Ser
			20					25					30		

Gly	Thr	Lys	Lys	Glu	Asn	Cys	Pro	Tyr	Ser	Ile	Leu	Glu	Ile	Thr	Ser
		35					40					45			

Val	Glu	Ile	Gly	Val	Val	Ala	Val	Lys	Ala	Ile	Asn	Ser	Asn	Tyr	Tyr
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-60-

50 55 60
 Leu Ala Met Asn Lys Lys Gly Lys Leu Tyr Gly Ser Lys Glu Phe Asn
 65 70 75 80
 Asn Asp Cys Lys Leu Lys Glu Arg Ile Glu Glu Asn Gly Tyr Asn Thr
 85 90 95
 Tyr Ala Ser Phe Asn Trp Gln His Asn Gly Arg Gln Met Tyr Val Ala
 100 105 110
 Leu Asn Gly Lys Gly Ala Pro Arg Arg Gly Gln Gln Thr Arg Arg Lys
 115 120 125
 Asn Thr Ser Ala His Phe Leu Pro Met Val Val His Ser
 130 135 140

<210> 133
 <211> 32
 <212> DNA
 <213> Homo sapiens

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 <212> DNA
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 tcgtgttttc tgccttccc ttggagctcc ttt 93

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 tacagcatcc tggagataac atcagtagaa atcggagttg ttgccgtcaa agccattaac 180
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-61-

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 aactggcagc ataatgggag gcaaatgtat gtggcattga atggaaaagg agctccaagg 360
 gaaggacaga aaacacgaag gaaaaacacc tctgctcact ttcttccaat ggtggtacac 420
 tcatag 426

<210> 136
 <211> 140
 <212> PRT
 <213> Homo sapiens

<400> 136
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 20 25 30
 Thr Lys Lys Glu Asn Cys Pro Tyr Ser Ile Leu Glu Ile Thr Ser Val
 35 40 45
 Glu Ile Gly Val Val Ala Val Lys Ala Ile Asn Ser Asn Tyr Tyr Leu
 50 55 60
 Ala Met Asn Lys Lys Gly Lys Leu Tyr Gly Ser Lys Glu Phe Asn Asn
 65 70 75 80
 Asp Cys Lys Leu Lys Glu Arg Ile Glu Glu Asn Gly Tyr Asn Thr Tyr
 85 90 95
 Ala Ser Phe Asn Trp Gln His Asn Gly Arg Gln Met Tyr Val Ala Leu
 100 105 110
 Asn Gly Lys Gly Ala Pro Arg Glu Gly Gln Lys Thr Arg Arg Lys Asn
 115 120 125
 Thr Ser Ala His Phe Leu Pro Met Val Val His Ser
 130 135 140

<210> 137
 <211> 32
 <212> DNA
 <213> Homo sapiens

<400> 137
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32

-62-

<210> 138
 <211> 93
 <212> DNA
 <213> Homo sapiens

<400> 138
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 tcgtgttttc tgtccctgcc ttggagctcc ttt 93

<210> 139
 <211> 426
 <212> DNA
 <213> Homo sapiens

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 agcaactatt acttagccat gaacaagaag gggaaactct atggctcaa agaatttaac 240
 aatgactgta agctgaagga gaggatagag gaaaatggat acaataccta tgcattcattt 300
 aactggcagc ataatgggag gcaaatgtat gtggcattga atggaaaagg agctccaagg 360
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 tcatag 426

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 <211> 141
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 20 25 30
 Gly Thr Lys Lys Glu Asn Cys Pro Tyr Ser Ile Leu Glu Ile Thr Ser
 35 40 45
 Val Glu Ile Gly Val Val Ala Val Lys Ala Ile Asn Ser Asn Tyr Tyr
 50 55 60

-63-

Leu Ala Met Asn Lys Lys Gly Lys Leu Tyr Gly Ser Lys Glu Phe Asn
 65 70 75 80

Asn Asp Cys Lys Leu Lys Glu Arg Ile Glu Glu Asn Gly Tyr Asn Thr
 85 90 95

Tyr Ala Ser Phe Asn Trp Gln His Asn Gly Arg Gln Met Tyr Val Ala
 100 105 110

Leu Asn Gly Lys Gly Ala Pro Arg Gln Gly Gln Lys Thr Arg Arg Lys
 115 120 125

Asn Thr Ser Ala His Phe Leu Pro Met Val Val His Ser
 130 135 140

<210> 141

<211> 32

<212> DNA

<213> Homo sapiens

<400> 141

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32

<210> 142

<211> 21

<212> DNA

<213> Homo sapiens

<400> 142

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21

<210> 143

<211> 21

<212> DNA

<213> Homo sapiens

<400> 143

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21

<210> 144

<211> 33

<212> DNA

<213> Homo sapiens

<400> 144

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33

-64-

<210> 145
 <211> 426
 <212> DNA
 <213> Homo sapiens

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 <211> 141
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 <213> Homo sapiens

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 35 40 45
 Val Glu Ile Gly Val Val Ala Val Lys Ala Ile Asn Ser Asn Tyr Tyr
 50 55 60
 Leu Ala Met Asn Lys Lys Gly Lys Leu Tyr Gly Ser Lys Glu Phe Asn
 65 70 75 80
 Asn Asp Cys Lys Leu Lys Glu Arg Ile Glu Glu Asn Gly Tyr Asn Thr
 85 90 95
 Tyr Ala Ser Phe Asn Trp Gln His Asn Gly Arg Gln Met Tyr Val Ala
 100 105 110
 Leu Asn Gly Glu Gly Ala Pro Arg Arg Gly Gln Lys Thr Arg Arg Lys
 115 120 125

-65-

Asn Thr Ser Ala His Phe Leu Pro Met Val Val His Ser
130 135 140

<210> 147

<211> 3974

<212> DNA

<213> Homo sapiens

<400> 147

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agaaattaca tatg 3974

<210> 148

<211> 112

<212> DNA

<213> Homo sapiens

<400> 148

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caattgtgag cggataacaa tttcacacat taaagaggag aaattacata tg

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INDICATIONS RELATING TO A DEPOSITED MICROORGANISM
(PCT Rule 13bis)

A. The indications made below relate to the microorganism referred to in the description on page 6, lines 22 and 23.	
B. IDENTIFICATION OF DEPOSIT	
Further deposits are identified on an additional sheet <input checked="" type="checkbox"/>	
Name of depositary institution American Type Culture Collection (ATCC)	
Address of depositary institution (including postal code and country) 10801 University Boulevard Manassas, Virginia 20110-2209 United States of America	
Formerly at: 12301 Parklawn Drive Rockville, Maryland 20852 United States of America	
Date of deposit 16 December 1994	Accession Number ATCC 75977
C. ADDITIONAL INDICATIONS (leave blank if not applicable)	
This information is continued on an additional sheet <input type="checkbox"/>	
DNA Plasmid 366885A	
In respect of those designations in which a European Patent is sought a sample of the deposited microorganism will be made available until the publication of the mention of the grant of the European patent or until the date on which the application has been refused or withdrawn or is deemed to be withdrawn, only by the issue of such a sample to an expert nominated by the person requesting the sample (Rule 28(4) EPC).	
D. DESIGNATED STATES FOR WHICH INDICATIONS ARE MADE (if the indications are not for all designated States)	
E. SEPARATE FURNISHING OF INDICATIONS (leave blank if not applicable)	
The indications listed below will be submitted to the international Bureau later (specify the general nature of the indications, e.g., "Accession Number of Deposit")	

For receiving Office use only
<input checked="" type="checkbox"/> This sheet was received with the international application
Authorized officer BPD - PCT (703) 805-8778

For International Bureau use only
<input type="checkbox"/> This sheet was received by the International Bureau on:
Authorized officer

Applicant's or agent's file
reference number 1488.106PC02

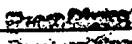
International application No.

PCT/US99/03018

PC/US 99 / 03018

INDICATIONS RELATING TO A DEPOSITED MICROORGANISM
(PCT Rule 13bis)

A. The indications made below relate to the microorganism referred to in the description on page 52, lines 28 and 29.	
B. IDENTIFICATION OF DEPOSIT Further deposits are identified on an additional sheet <input type="checkbox"/>	
Name of depositary institution American Type Culture Collection (ATCC)	
Address of depositary institution (including postal code and country) 10801 University Boulevard Manassas, Virginia 20110-2209 United States of America	
Formerly at: 12301 Parklawn Drive Rockville, Maryland 20852 United States of America	
Date of deposit 09 January 1998	Accession Number ATCC 209575
C. ADDITIONAL INDICATIONS (leave blank if not applicable) This information is continued on an additional sheet <input type="checkbox"/>	
DNA Plasmid pHEKGF-2delta33	
In respect of those designations in which a European Patent is sought a sample of the deposited microorganism will be made available until the publication of the mention of the grant of the European patent or until the date on which the application has been refused or withdrawn or is deemed to be withdrawn, only by the issue of such a sample to an expert nominated by the person requesting the sample (Rule 28(4) EPC).	
D. DESIGNATED STATES FOR WHICH INDICATIONS ARE MADE (if the indications are not for all designated States)	
E. SEPARATE FURNISHING OF INDICATIONS (leave blank if not applicable)	
The indications listed below will be submitted to the international Bureau later (specify the general nature of the indications, e.g., "Accession Number of Deposit")	

For receiving Office use only	For International Bureau use only
<input checked="" type="checkbox"/> This sheet was received with the international application	<input type="checkbox"/> This sheet was received by the International Bureau on:
Authorized officer  209575 - 107 (703) 833-8578	Authorized officer

DNA Plasmid pHEKGF-2delta33**AUSTRALIA**

The applicant hereby gives notice that the furnishing of a sample of a microorganism shall only be effected prior to the grant of a patent, or prior to the lapsing, refusal or withdrawal of the application, to a person who is a skilled addressee without an interest in the invention (Regulation 3.25(3) of the Australian Patents Regulations).

CANADA

The applicant hereby requests that, until either a Canadian patent has been issued on the basis of the application or the application has been refused, or is abandoned and no longer subject to reinstatement, or is withdrawn, the furnishing of a sample of deposited biological material referred to in the application only be effected to an independent expert nominated by the Commissioner of Patents.

DENMARK

The applicant hereby requests that, until the application has been laid open to public inspection (by the Danish Patent Office), or has been finally decided upon by the Danish Patent Office without having been laid open to public inspection, the furnishing of a sample shall only be effected to an expert in the art. The request to this effect shall be filed by the applicant with the Danish Patent Office not later than at the time when the application is made available to the public under Sections 22 and 33(3) of the Danish Patents Act. If such a request has been filed by the applicant, any request made by a third party for the furnishing of a sample shall indicate the expert to be used. That expert may be any person entered on a list of recognized experts drawn up by the Danish Patent office or any person approved by the applicant in the individual case.

FINLAND

The applicant hereby requests that, until the application has been laid open to public inspection (by the National Board of Patents and Registration), or has been finally decided upon by the National Board of Patents and Registration without having been laid open to public inspection, the furnishing of a sample shall only be effected to an expert in the art. The request to this effect shall be filed by the applicant with the International Bureau before the expiration of 16 months from the priority date (preferably on the Form PCT/RO/134 reproduced in annex Z of Volume I of the PCT Applicant's Guide). If such a request has been filed by the applicant, any request made by a third party for the furnishing of a sample shall indicate the expert to be used. That expert may be any person entered on a list of recognized experts drawn up by the National Board of Patents and Registration or any person approved by the applicant in the individual case.

ICELAND

The applicant hereby requests that, until the application has been laid open to public inspection (by the Icelandic Patent Office), or has been finally decided upon by the Icelandic Patent Office without having been laid open to public inspection, the furnishing of a sample shall only be effected to an expert in the art.

DNA Plasmid pHEKGF-2delta33**NETHERLANDS**

The applicant hereby requests that until the date of a grant of a Netherlands patent or until the date on which the application is refused or withdrawn or lapsed, the microorganism shall be made available as provided in Rule 31F(1) of the Patent Rules only by the issue of a sample to an expert. The request to this effect must be furnished by the applicant with the Netherlands Industrial Property Office before the date on which the application is made available to the public under Section 22C or Section 25 of the Patents Act of the Kingdom of the Netherlands, whichever of the two dates occurs earlier.

NORWAY

The applicant hereby requests that, until the application has been laid open to public inspection (by the Norwegian Patent Office), or has been finally decided upon by the Norwegian Patent Office without having been laid open to public inspection, the furnishing of a sample shall only be effected to an expert in the art. The request to this effect shall be filed by the applicant with the Norwegian Patent Office not later than at the time when the application is made available to the public under Sections 22 and 33(3) of the Norwegian Patents Act. If such a request has been filed by the applicant, any request made by a third party for the furnishing of a sample shall indicate the expert to be used. That expert may be any person entered on a list of recognized experts drawn up by the Norwegian Patent office or any person approved by the applicant in the individual case.

SINGAPORE

The applicant hereby requests that the furnishing of a sample of a microorganism shall only be made available to an expert. The request to this effect must be filed by the applicant with the International Bureau before the completion of the technical preparations for international publication of the application.

SWEDEN

The applicant hereby requests that, until the application has been laid open to public inspection (by the Swedish Patent Office), or has been finally decided upon by the Swedish Patent Office without having been laid open to public inspection, the furnishing of a sample shall only be effected to an expert in the art. The request to this effect shall be filed by the applicant with the International Bureau before the expiration of 16 months from the priority date (preferably on the Form PCT/RO/134 reproduced in annex Z of Volume I of the PCT Applicant's Guide). If such a request has been filed by the applicant, any request made by a third party for the furnishing of a sample shall indicate the expert to be used. That expert may be any person entered on a list of recognized experts drawn up by the Swedish Patent office or any person approved by the applicant in the individual case.

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DNA Plasmid 366885A**AUSTRALIA**

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/03018

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :C07K 14/475, 14/50; A61K 38/18

US CL :514/2, 12; 530/399

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 514/2, 12; 530/399

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Please See Extra Sheet.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A,P	US 5,824,643 A (PIERCE et al) 20 October 1998, col. 2, lines 6-48.	1-68
A	US 5,677,278 A (GOSPODAROWICZ et al) 14 October 1997, see entire document.	1-68
A	US 5,703,047 A (WILSON) 30 December 1997, col. 3, line 23 to col. 4, line 65.	1-68
A,P	US 5,731,170 A (RUBIN et al) 24 March 1998, see entire document.	1-68
A,P	US 5,843,883 A (GOSPODAROWICZ et al) 01 December 1998, see entire document.	1-68

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:	*T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
A document defining the general state of the art which is not considered to be of particular relevance	*X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
B earlier document published on or after the international filing date	*Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
L document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	*Z* document member of the same patent family
O document referring to an oral disclosure, use, exhibition or other means	
P document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 26 APRIL 1999	Date of mailing of the international search report 14 MAY 1999
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer CHRISTINE SAOUD Telephone No. (703) 308-0196

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/03018

B. FIELDS SEARCHED

Electronic data bases consulted (Name of data base and where practicable terms used):

APS, MEDLINE, EMBASE, BIOSIS

search terms: keratinocyte growth factor, kgf, kgf-2, treatment, administration, platelets, thrombocytopenia, fibrinogen, serum albumin, globulin, bladder, prostate, salivary gland, lacrimal gland, sinus epithelium, goblet cells